Instruction Report ITL-96-2
June 1996

US Army Corps of Engineers
Waterways Experiment Station

Computer-Aided Structural Engineering (CASE) Project

Computer-Aided Structural Modeling (CASM)

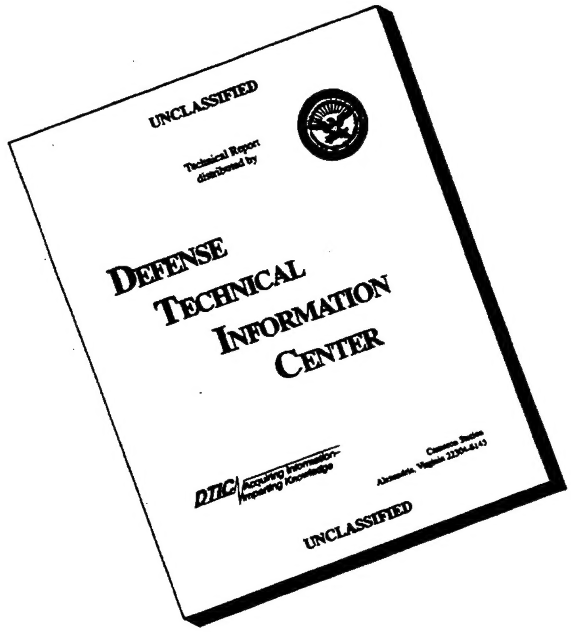
Version 6.00

Report 3
Scheme A

by *David Wickersheimer, Carl Roth, Gene McDermott*
Wickersheimer Engineers, Inc.

Prepared for Headquarters, U.S. Army Corps of Engineers

DISCLAIMER NOTICE



Instruction Report ITL-96-2
June 1996

Computer-Aided Structural Modeling (CASM)

Version 6.00

Report 3
Scheme A

by David Wickersheimer, Carl Roth, Gene McDermott

Wickersheimer Engineers, Inc.
821 South Neil Street
Champaign, IL 61820

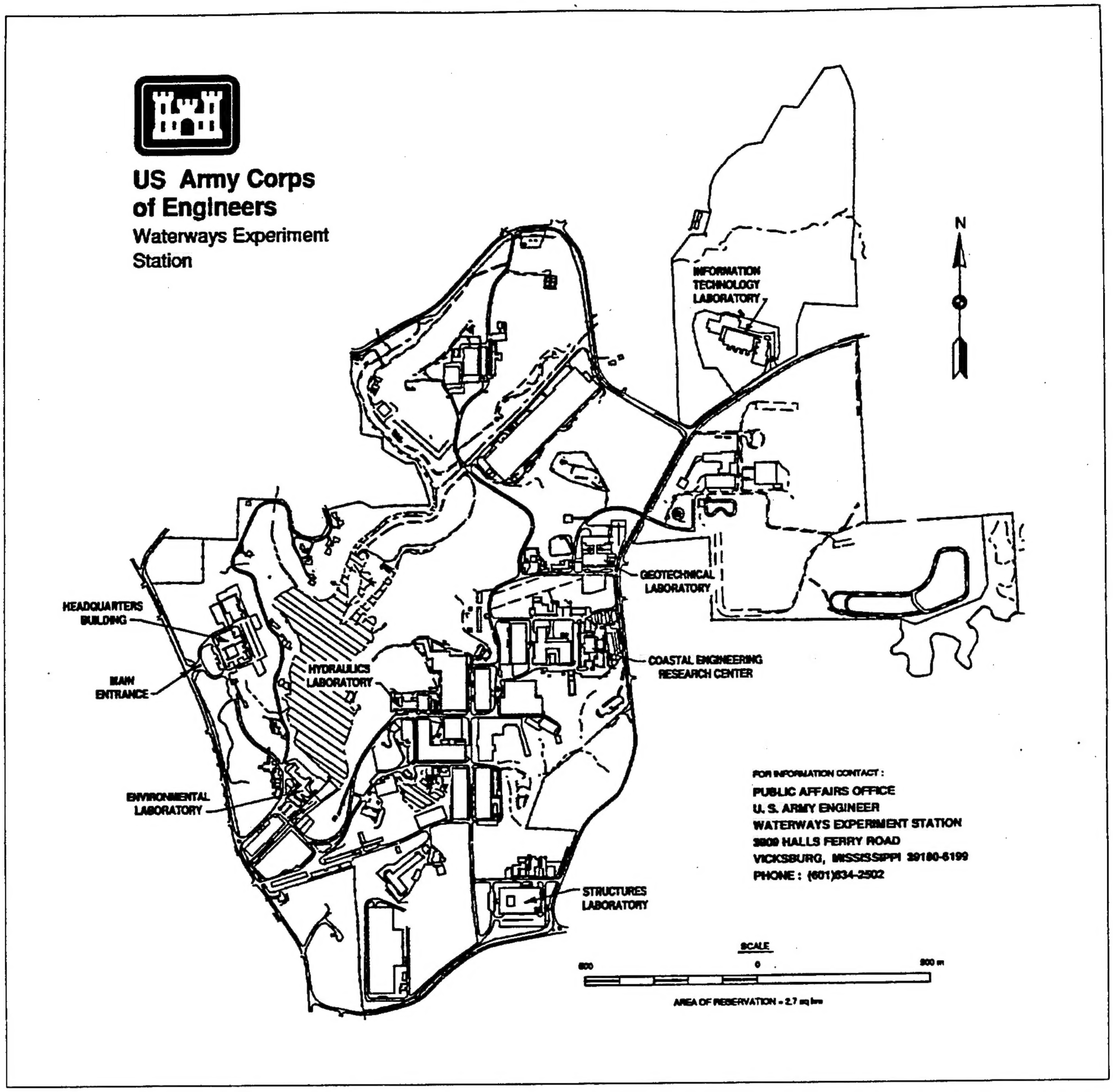
Report 3 of a series

Approved for public release; distribution is unlimited

Prepared for U.S. Army Corps of Engineers
Washington, DC 20314-1000

Monitored by U.S. Army Engineer Waterways Experiment Station
3909 Halls Ferry Road, Vicksburg, MS 39180-6199

Under Work Unit AT40-CA-001



Waterways Experiment Station Cataloging-in-Publication Data

Wickersheimer, David.

Computer-Aided Structural Modeling (CASM) : version 6.00. Report 3, Scheme A / by David Wickersheimer, Carl Roth, Gene McDermott ; prepared for U.S. Army Corps of Engineers ; monitored by U.S. Army Engineer Waterways Experiment Station.

202 p. : ill. ; 28 cm. -- (Instruction report ; ITL-96-2 rept.3)

Includes bibliographic references.

Report 3 of a series.

1. Structural engineering -- Computer programs. 2. Computer-aided engineering. 3. Structural analysis (Engineering) -- Computer programs. 4. Loads (Forces) -- Data processing. I. Roth, Carl. II. McDermott, Gene. III. United States. Army. Corps of Engineers. IV. U.S. Army Engineer Waterways Experiment Station. V. Information Technology Laboratory (U.S. Army Engineer Waterways Experiment Station) VI. Computer-aided Structural Engineering Project. VII. Title. VIII. Series: Instruction report (U.S. Army Engineer Waterways Experiment Station) ; ITL-96-2 rept.3.

TA7 W34i no.ITL-96-2 rept.3

PREFACE

This report describes the computer program CASM, which is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional interactive graphics, to determine the structural framing scheme for a rigid frame, all steel, noncomposite, with lateral load resistance. Funds for the development of this program and publication of this user's guide were provided to the Information Technology Laboratory (ITL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, by the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE), under the Research, Development, Test, and Evaluation (RDT&E) program. The work was accomplished under Work Unit No. AT40-CA-001 entitled "CASE (Computer Aided Structural Engineering) Building Systems." The work was performed by members of Wickersheimer Engineers, Inc., of Champaign, IL, under Contract No. DACA39-86-C-0024.

Specifications for the program were provided by members of the Building Systems Task Group of the CASE Project. The following were members of the task group during program development:

Mr. Dan Reynolds, U.S. Army Engineer (USAE) District, Sacramento (Chairman)

Ms. Anjana Chudgar, USAE Division, Ohio River

Mr. Pete Rossbach, USAE District, Baltimore

Mr. Dave Smith, USAE District, Omaha

Mr. Mark Burkholder, USAE District, Tulsa

Mr. Jerry Maurseth, USAE District, Portland

Mr. Chris Merrill, WES

Mr. Michael Pace, WES

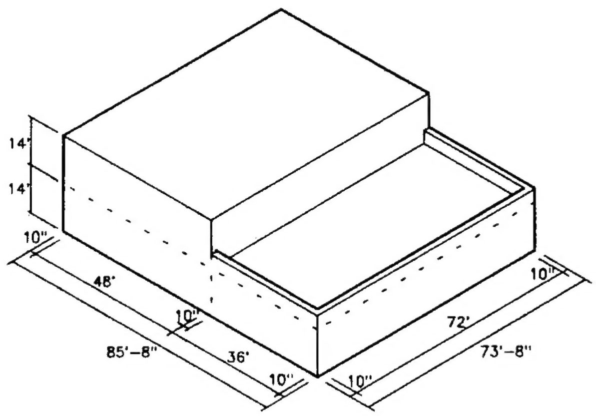
The computer program and report were written by Messrs. David Wickersheimer, Gene McDermott, and Carl Roth of Wickersheimer Engineers, Inc.

The work was monitored at WES by Mr. Michael E. Pace and Mr. Chris Merrill, Computer-Aided Engineering Division (CAED), under the general supervision of Mr. H. Wayne Jones, Chief, Scientific and Engineering Applications Center; Dr. Reed Mosher, Chief, CAED; Mr. Timothy Ables, Assistant Director, ITL; and Dr. N. Radhakrishnan, Director, ITL. Mr. Donald Dressler was the original HQUSACE point of contact, and Mr. Charlie Gutberlet is the present technical monitor.

Dr. Robert W. Whalin is Director of WES. COL Bruce K. Howard, EN, is Commander.

Table of Contents

Project Description



This 1 and 2 story project is to provide approximately 9,500 gross square feet of office space for one of two possible sites:

(a) Charleston, South Carolina

(b) Radford AAP, Virginia

Soil conditions are unknown at both sites.

The following project criteria has been established:

1. The 36' x 72' space on the first level shall be column free for open office planning.

2. The 48' x 72' first and second floor areas shall provide 24' square bays.

3. The first floor shall be a slab on grade with the tops of perimeter continuous wall footings set at 2'-6" below grade. Column footings will be isolated spread footings.

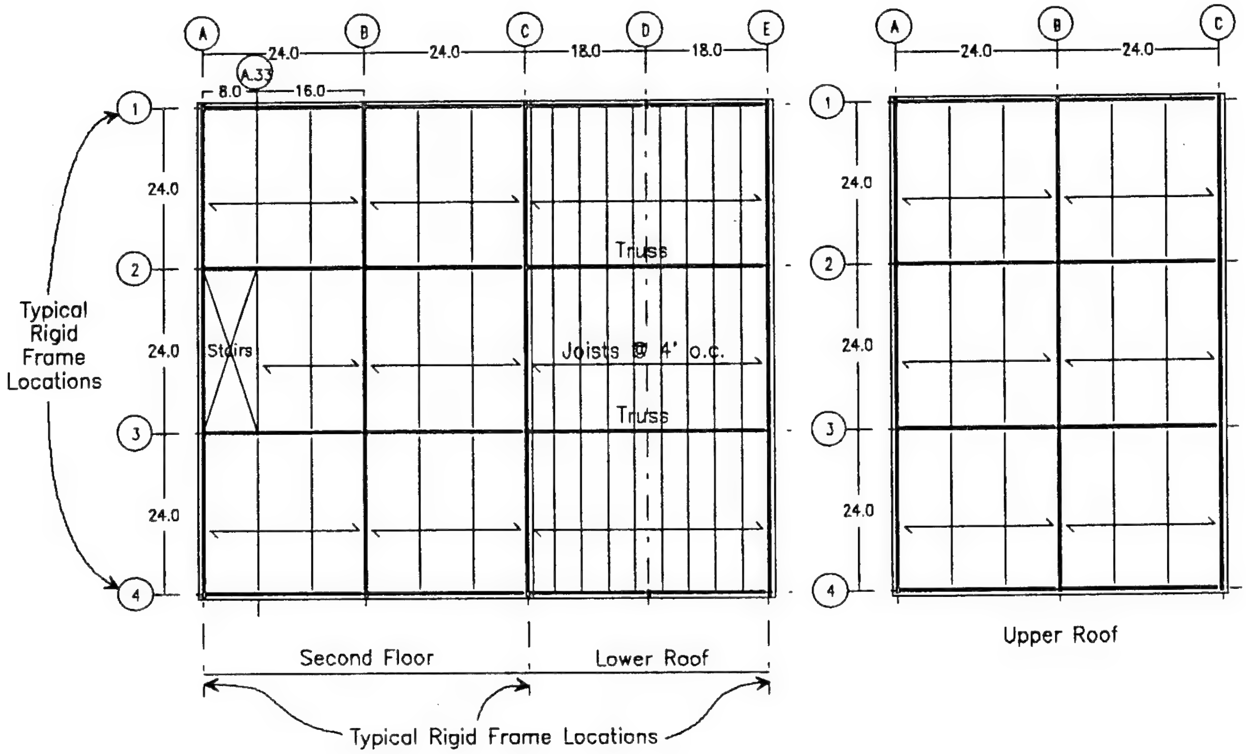
4. The second floor occupancy live loads located on the plan are:

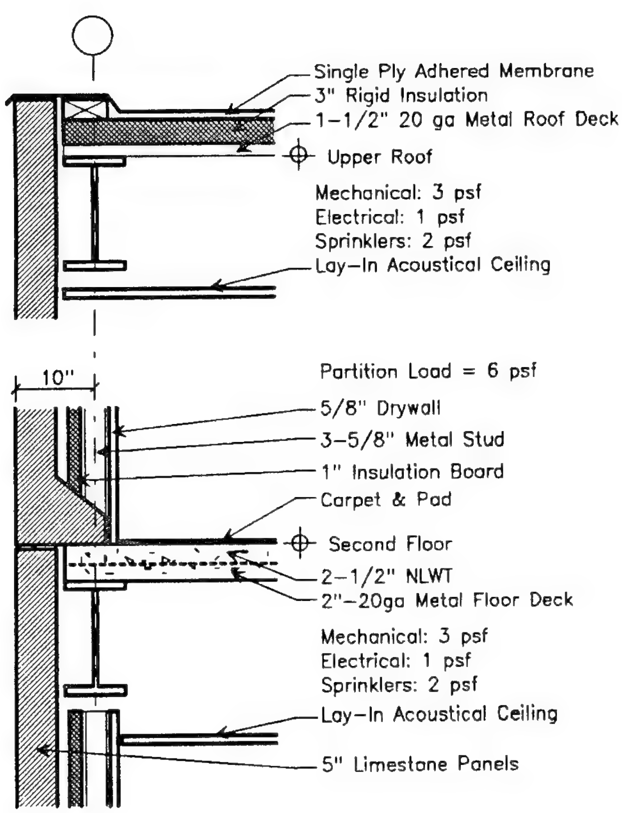
Offices:	50 psf
File Storage:	150 psf
Corridor, Stair & Lobby:	100 psf

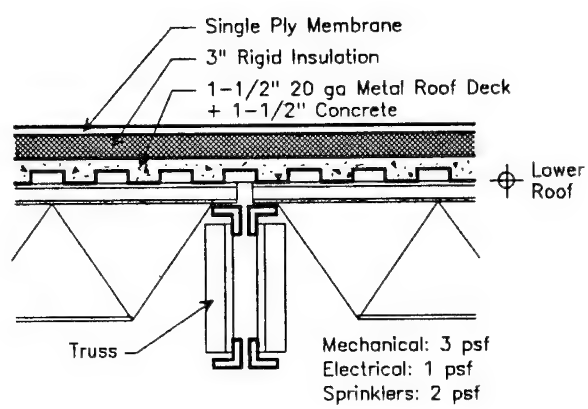
5. Structural framing schemes to be designed and compared shall be as follows:

Scheme A:	All steel, non-composite, lateral load resistance = rigid frames.
Scheme B:	All steel, composite, lateral load resistance = X braced frames.
Scheme C:	Monolithic concrete for two story portion, steel for lower roof portion, lateral load resistance = shear walls.

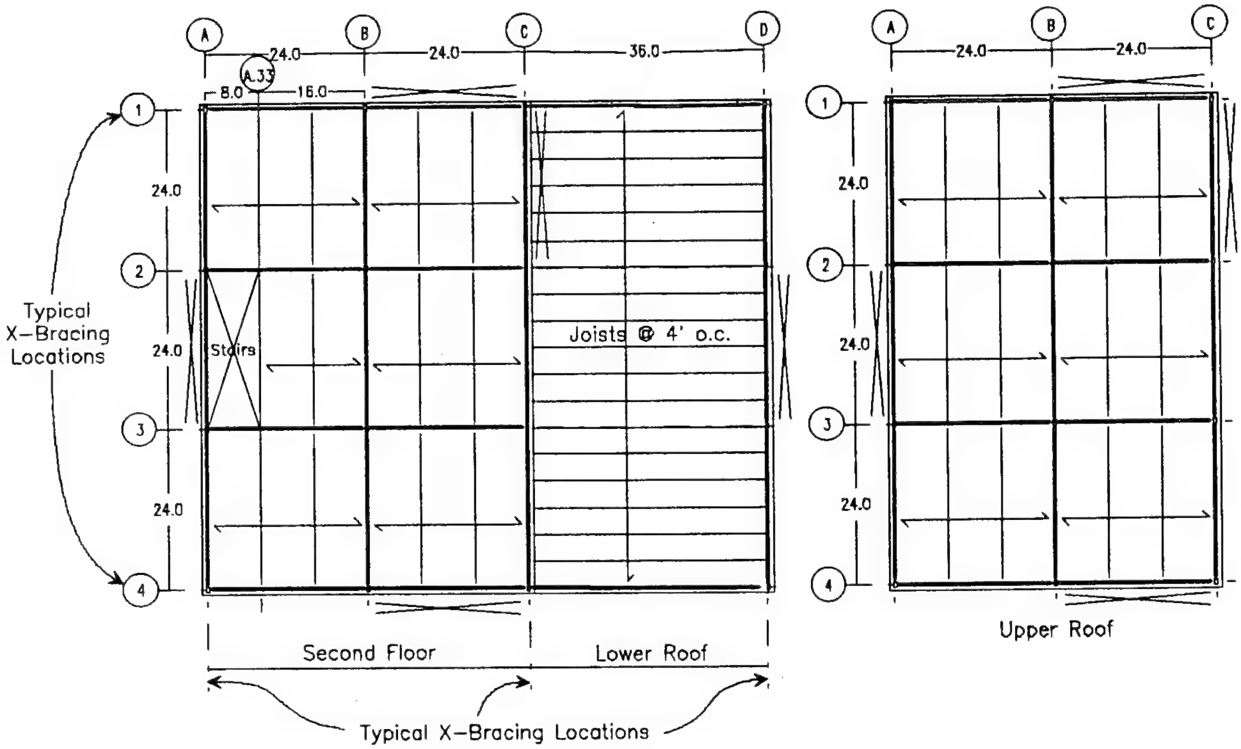
Scheme A

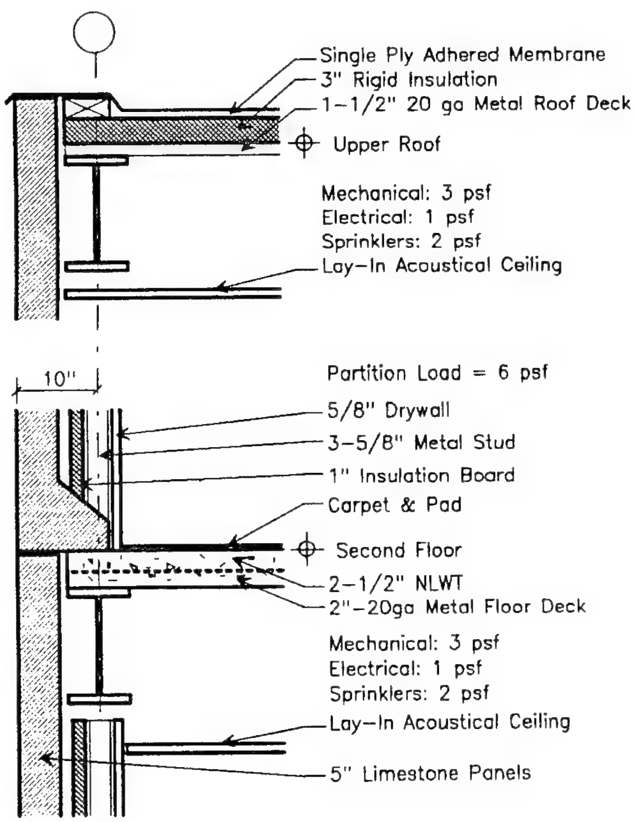

A
B
C
D
E
24.0
24.0
18.0
18.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Typical Rigid Frame Locations
Stairs
Truss
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
Typical Rigid Frame Locations
Upper Roof

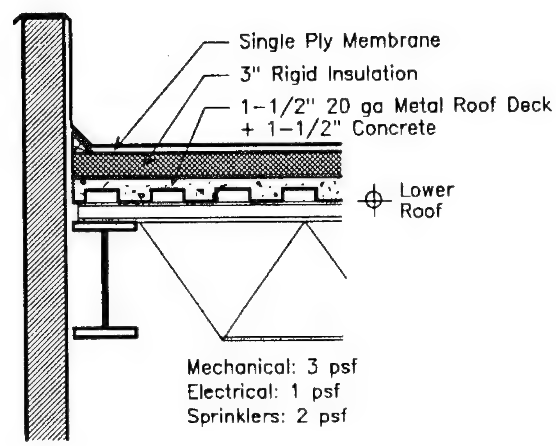

Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

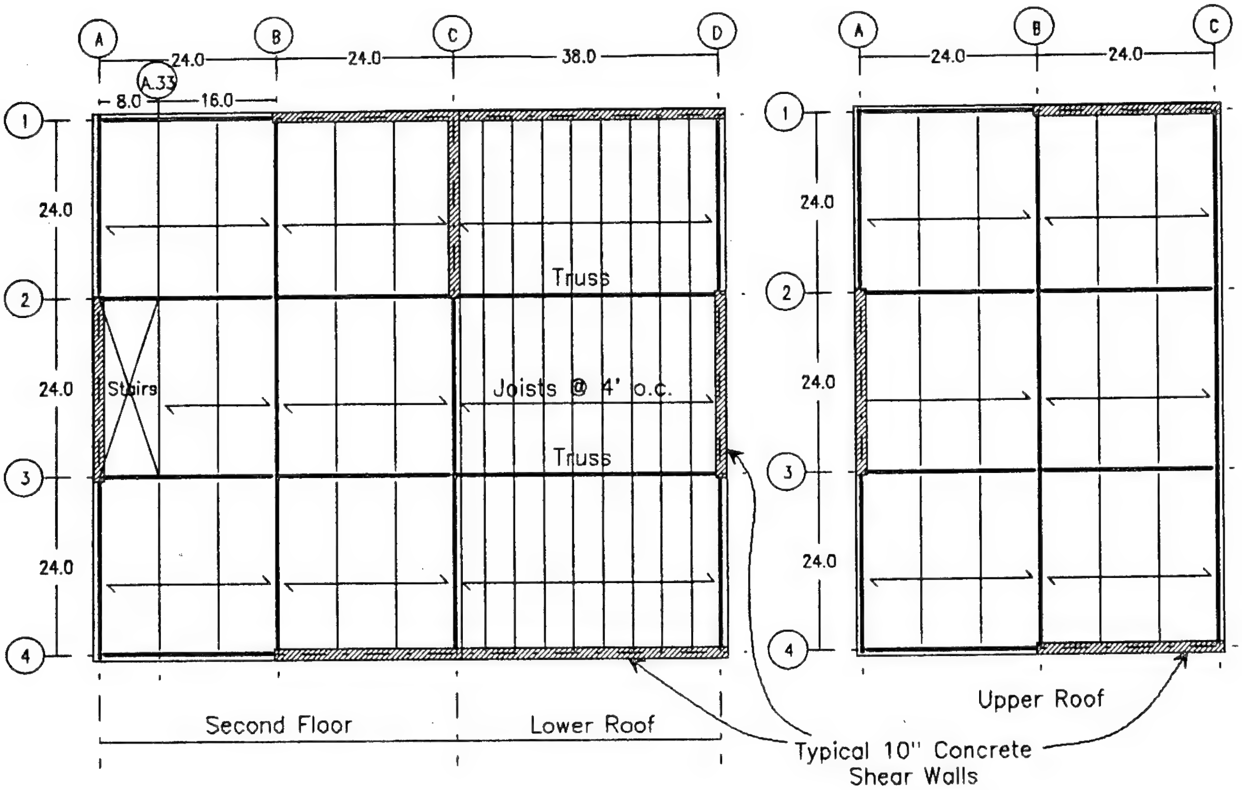
Scheme B

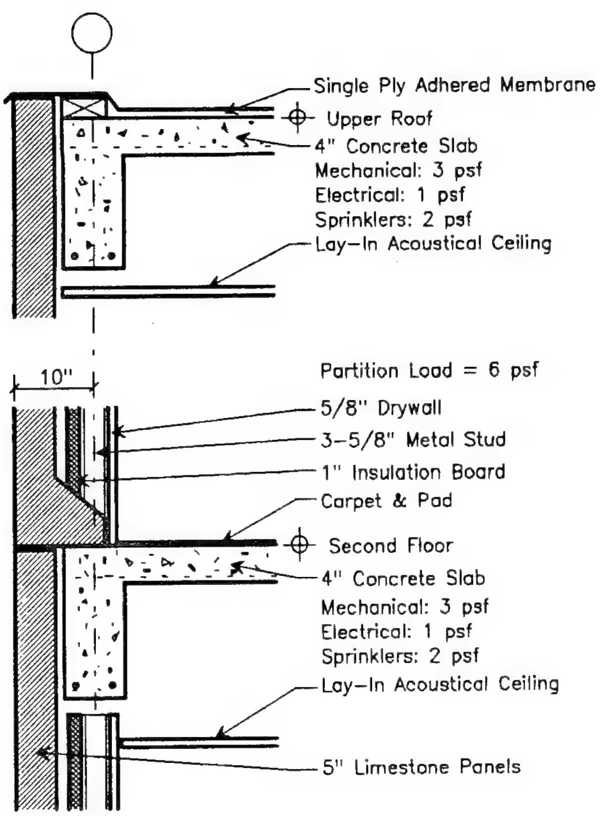

A
B
C
D
24.0
24.0
36.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Typical X-Bracing Locations
Stairs
Joists @ 4' o.c.
Second Floor
Lower Roof
Typical X-Bracing Locations
A
B
C
24.0
24.0
1
2
3
4
24.0
24.0
24.0
Upper Roof

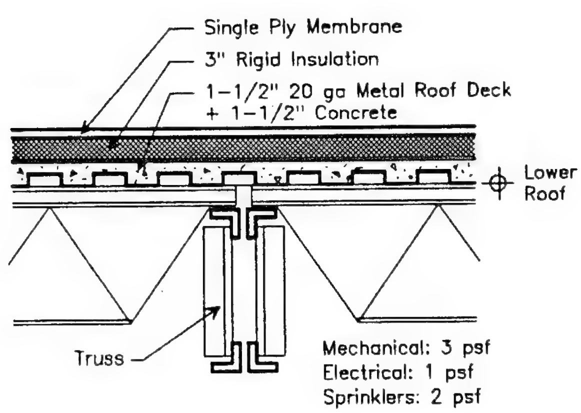

Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

Scheme C


A
B
C
D
A.33
24.0
24.0
38.0
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Stairs
Truss
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
A
B
C
24.0
24.0
Upper Roof
Typical 10" Concrete Shear Walls


Single Ply Adhered Membrane
Upper Roof
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck + 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

6. The typical exterior envelope consists of 5" limestone panels, 1" rigid insulation, 3-5/8" metal studs, and 5/8" drywall.

7. Window and door openings are uniformly distributed to all elevations.

8. Load Assumptions:

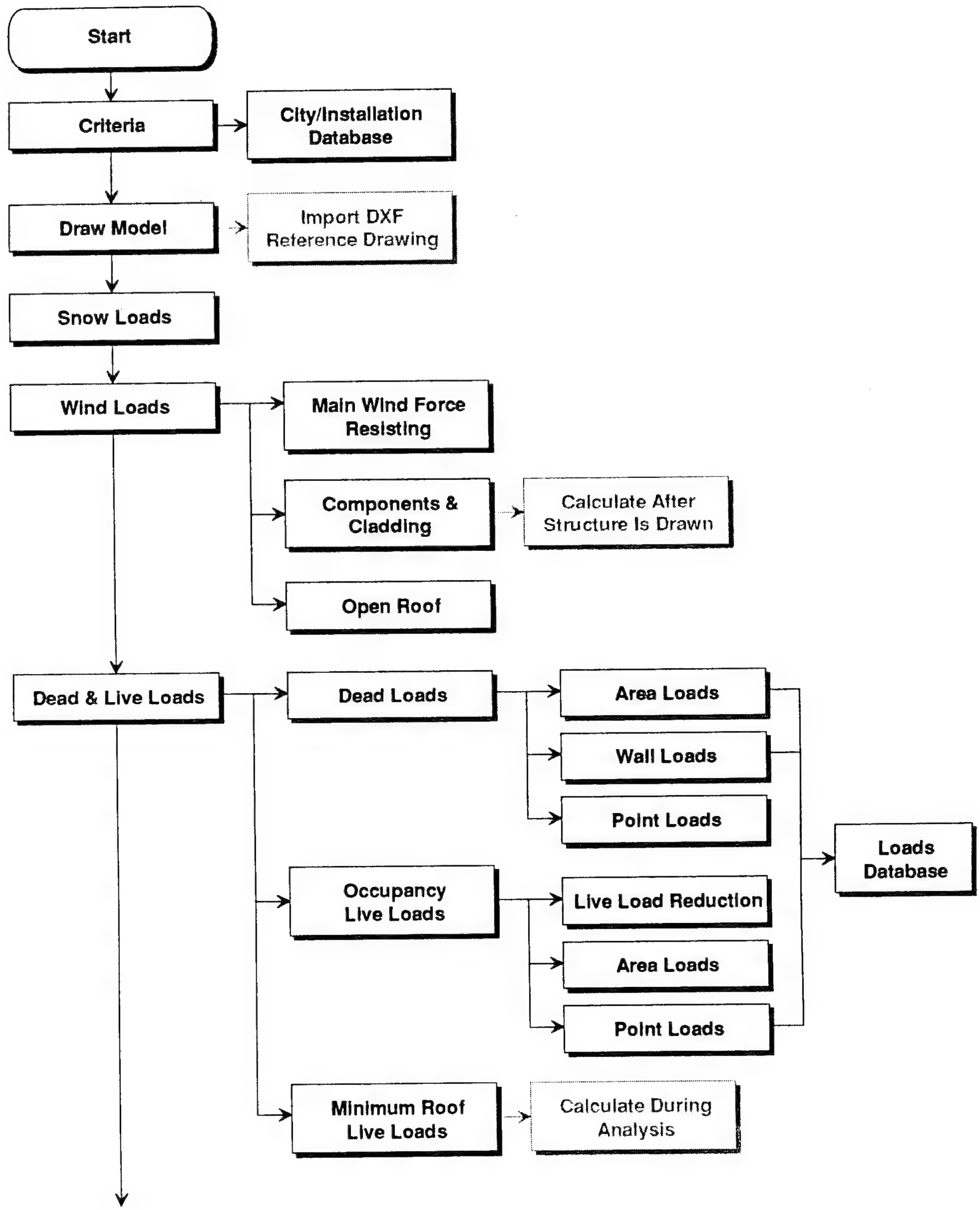
	Importance Category	Exposure Category
Snow:	I	C
Wind:	I	C
Seismic:	IV	

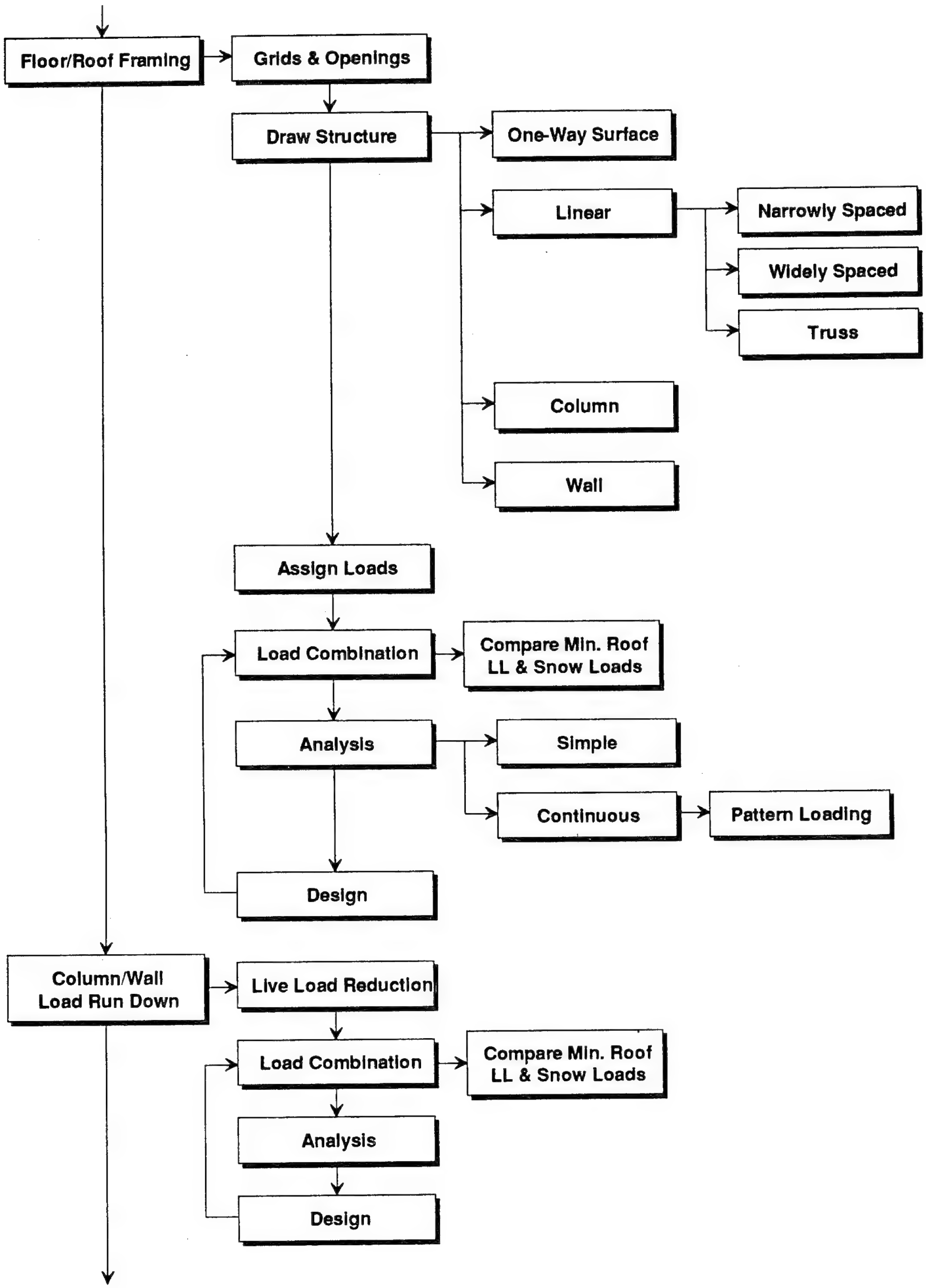
9. Material Assumptions:

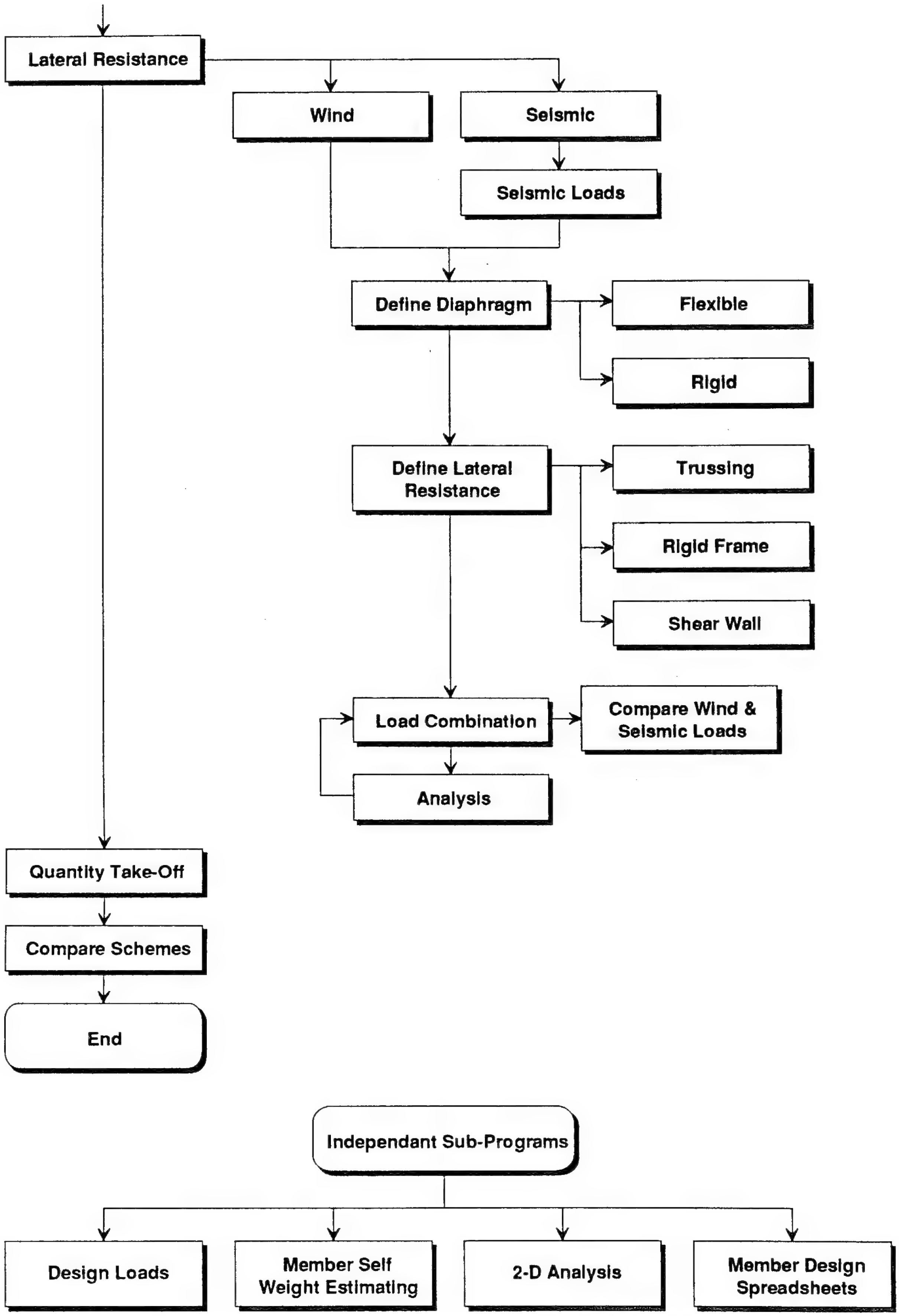
Concrete:	4,000 psi, NLWT
	Steel Reinforcing: Grade 60
Steel:	A36

10. Fire resistance rating shall be achieved by a wet sprinkler system.

Computer Aided Structural Modeling




Floor/Roof Framing
Grids & Openings
Draw Structure
One-Way Surface
Linear
Narrowly Spaced
Widely Spaced
Truss
Column
Wall
Assign Loads
Load Combination
Compare Min. Roof LL & Snow Loads
Analysis
Simple
Continuous
Pattern Loading
Design
Column/Wall Load Run Down
Live Load Reduction
Load Combination
Compare Min. Roof LL & Snow Loads
Analysis
Design


Lateral Resistance
Wind
Seismic
Seismic Loads
Define Diaphragm
Flexible
Rigid
Define Lateral Resistance
Trussing
Rigid Frame
Shear Wall
Load Combination
Compare Wind & Seismic Loads
Analysis
Quantity Take-Off
Compare Schemes
End
Independant Sub-Programs
Design Loads
Member Self Weight Estimating
2-D Analysis
Member Design Spreadsheets

Criteria

Start

Use Criteria Menu

Project

Project Data

Project Name:	Office Building - Scheme A
City/Installation:	Radford AAP
Country:	USA
State:	VA
County:	Pulaski
Design Load:	TM 5-809-1 1992
Building Code:	BOCA
Seismic Code:	TM 5-809-10 1992
Elevation Above Sea Level:	3300 ft
No. Of Stories:	2
Floor Area:	9504 sq ft
Occupancy:	Use Group B
Type Const:	3A
Seismic Lateral Load Resistance	
N-S System:	Blank
E-W System:	Blank

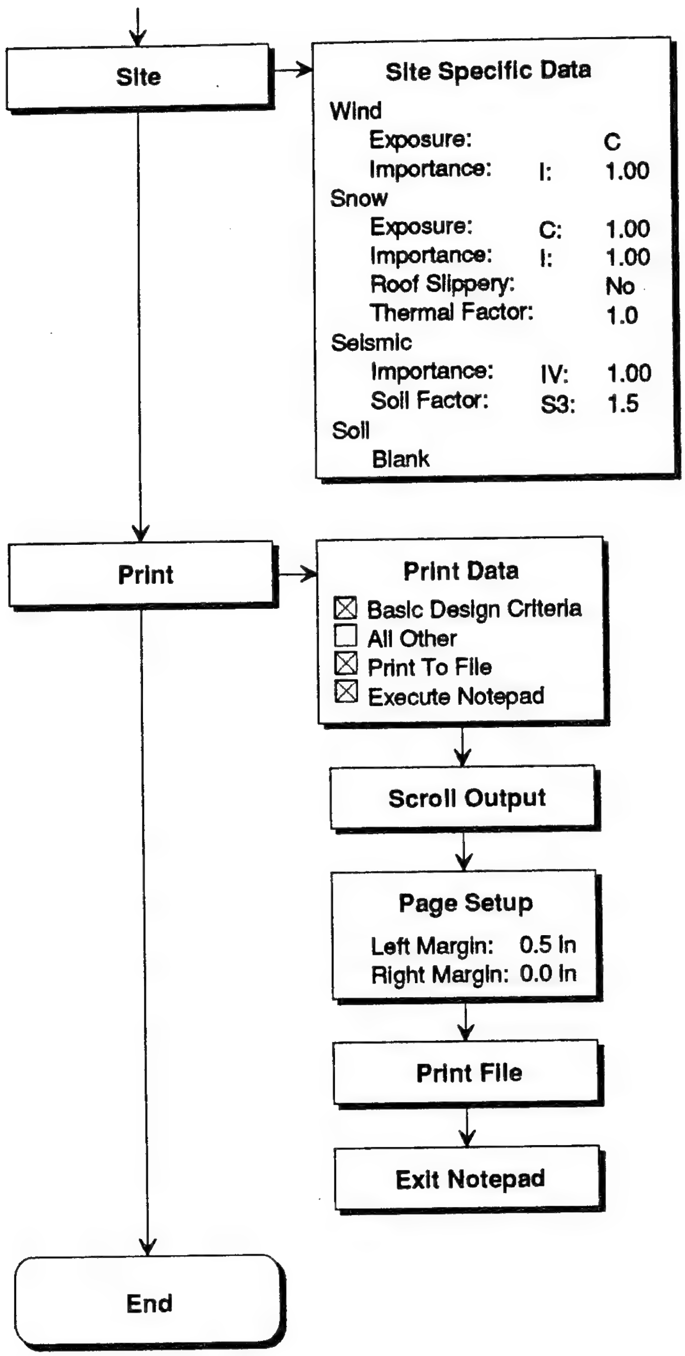
City/Installation

Select Radford AAP From List

Regional

Review Regional Data

Wind		
Basic Wind Speed:	70.0	mph
Coastal:	No	
Maximum Wind Speed:	58.0	mph
Wind Direction:	SE	
Snow		
Ground Snow Load:	25.0	psf
Maximum Snow Depth:	15.0	in
Snow Density:	17.3	pcf
Rain		
Average Annual Rainfall:	44.0	in
Maximum Rainfall:	4.0	in
Temperature		
Maximum temperature:	92	°F
Minimum Temperature:	-24	°F
Seismic Zone: 2A:	0.150	
Frost Depth:	22	in


Site
Site Specific Data
Wind
Exposure: C
Importance: I: 1.00
Snow
Exposure: C: 1.00
Importance: I: 1.00
Roof Slippery: No
Thermal Factor: 1.0
Seismic
Importance: IV: 1.00
Soil Factor: S3: 1.5
Soil
Blank
Print
Print Data
☒ Basic Design Criteria
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

```
Basic Design Criteria

Project Data
    Project Name                  : Office Building - Scheme A
    City/Installation             : Radford AAP
    Country                       : USA
    State                         : VA
    County                        : Pulaski
    Design Load                   : TM 5-809-1 1992
    Building Code                 : BOCA
    Seismic Code                  : TM 5-809-10 1992
    Elevation Above Sea Level :     3300 ft
    No. of Stories                :      2
    Floor Area                    :   9504 sqft
    Occupancy                     : Use Group B
    Type of Construction          : 3A
    Seismic Lateral Load Resistance
      N-S System                  :
      N-S Rw                      :      0
      E-W System                  :
      E-W Rw                      :      0

Regional Data
  Wind
    Basic Wind Speed From Map :     70.0 mph
    Calculated Wind Speed     :      0.0 mph
    Coastal                   :       No
    Maximum Wind Speed        :     58.0 mph
    Wind Direction            :       SE
  Snow
    Ground Snow Load          :     25.0 psf
    Maximum Snow Depth        :     15.0 in
    Snow Density              :     17.3 pcf
  Rain
    Average Annual Rainfall   :     44.0 in
    Maximum Rainfall          :      4.0 in
  Temperature
    Maximum Temperature       :     92.0 °F
    Minimum Temperature       :    -24.0 °F
  Seismic Zone   : 2A         :    0.150
  Frost Depth                 :       22 in

Site Specific Data
  Wind
    Exposure                  :        C
    Importance   : I          :     1.00
  Snow
    Exposure     : C          :     1.00
    Importance   : I          :     1.00
    Roof Slippery             :       No
    Thermal Factor            :      1.0
  Seismic
    Importance   : IV         :     1.00
    Soil Factor  : S3         :      1.5

Notes
  Importance Factor for Snow and Wind:
    I   All buildings and structures except those listed below.
    II  Buildings and structures where primary occupancy is one in which
        more than 300 people congregate in one area.
    III Buildings and structures designated as essential facilities,
        including, but not limited to:
          Hospital and other medical facilities having surgery or emergency
          treatment areas.
          Fire or rescue and police stations.
          Primary communication facilities and disaster operation centers.
          Power stations and other utilities required in an emergency.
```

Structures having critical national defense capabilities.

IV Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, certain temporary facilities, and minor storage facilities.

Wind Exposure Category:

Exposure C:

Open terrain with scattered obstructions having heights generally less than 30.0 ft.

Snow Exposure Category:

Exposure C:

Locations in which snow removal by wind cannot be relied on to reduce roof loads because of terrain, higher structures, or several trees nearby.

* The conditions discussed should be representative of those that are likely to exist during the life of the structure. Roofs that contain several large pieces of mechanical equipment or other obstructions do not qualify for siting category A.

Snow Thermal Factor:

Heated Structure.

* These conditions should be representative of those that are likely to exist during the life of the structure.

Importance Factor for Seismic:

I. Essential Facilities

Hospitals and other medical facilities having surgery and emergency treatment areas.

Fire and police stations.

Tanks or other structures containing, housing or supporting water or other fire-suppression materials or equipment required for the protection of essential or hazardous facilities, or special occupancy structures.

Emergency vehicle shelters and garages.

Structures and equipment in emergency preparedness centers.

Stand-by power generating equipment for essential facilities.

Structures and equipment in communication centers and other facilities required for emergency response.

II. Hazardous Facilities

Structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be dangerous to the safety of the general public if released.

III. Special Occupancy Structure

Covered structures whose primary occupancy is public assembly - capacity more than 300 persons.

Buildings for schools (through secondary) or day-care centers - capacity more than 250 students.

Buildings for colleges or adult education schools - capacity more than 500 students.

Medical facilities with 50 or more resident incapacitated patients, but not included above.

Jails and detention facilities.

All structures with occupancy more than 5000 persons.

Structures and equipment in power generating stations and other public utility facilities not included above, and required for continued operation.

IV. Standard Occupancy Structure

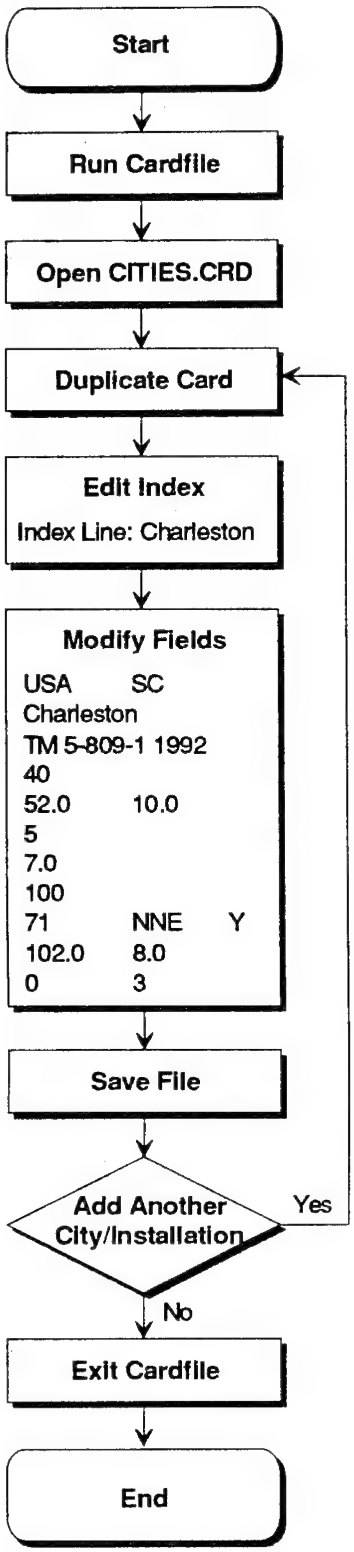
All Structures having occupancies or functions not listed above.

Seismic Soil Factor:

S3: A soil profile 70.0 ft or more in depth and containing more than 20.0 ft of soft to medium stiff clay but not more than 40.0 ft of soft clay.

The site factor shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type, soil profile S3 shall be used. Soil profile S4 need not be assumed unless the Building Official determines that soil profile S4 may be present at the site, or in the event that soil profile S4 is established by geotechnical data.

City/Installation Database



Fields

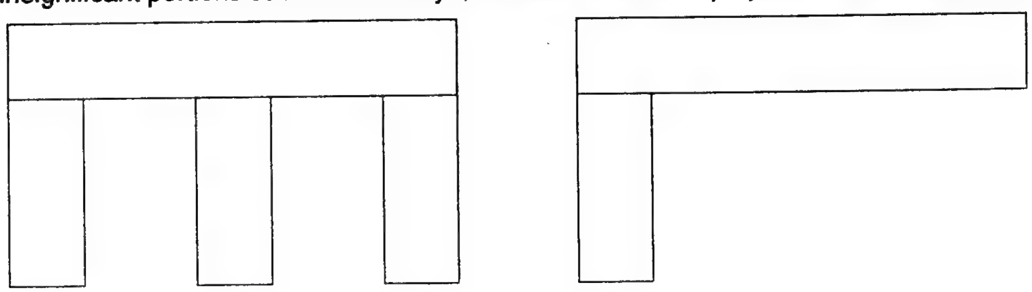
Country	State	*Metric*
County		
Design Load		
Elevation (ft)		
Ave. Rain (in)	Max. Rain (in)	
Ground Snow Load (psf)		
Max. Snow Depth (in)		
Basic Wind Speed (mph)		
Max. Wind Speed (mph)	Wind Direction	Coastal (Y/N)
Max. Temp. (°F)	Min. Temp. (°F)	
Frost Depth (in)	Seismic Zone	

Modeling Philosophy

A. Simplify the geometric model

For buildings with repetitive wings, only one wing needs to be modeled.

Insignificant portions such as chimneys, dormers, and small projections, should not be modeled.



Extra wings are not necessary

Simplified model

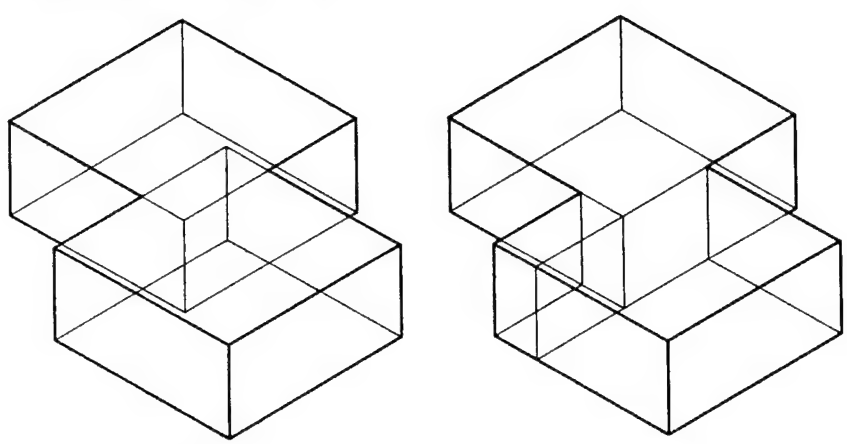
B. Make sure planes are in contact

A gap between adjoining shapes will make the surfaces exterior.

Use the Stack options to accurately place adjoining shapes.

C. Do not intersect shapes

When modeling parapet walls, make sure the corners do not intersect.



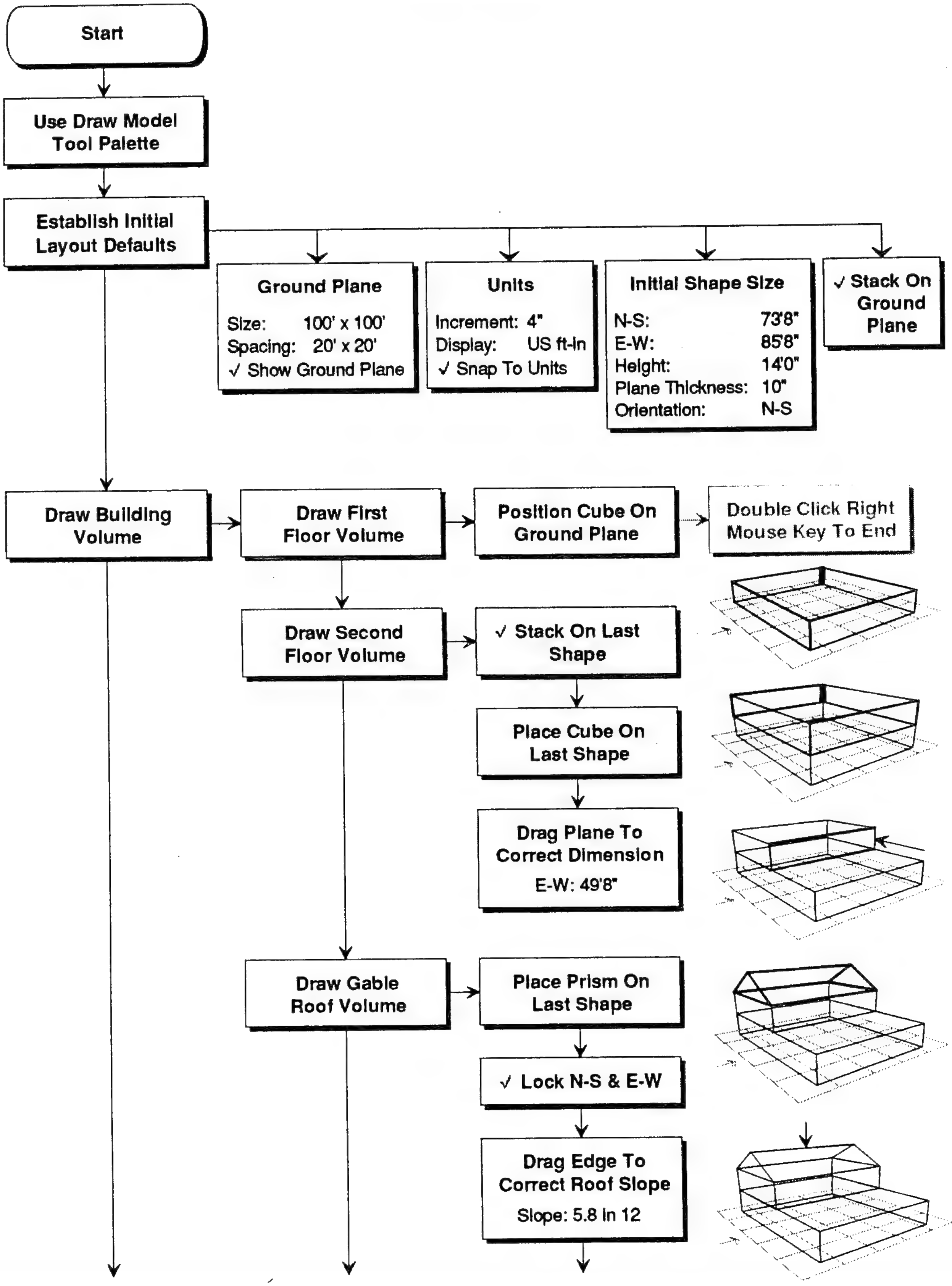
Incorrect

Correct

D. Verify the model

Use the Tape Measure command, zoom in on a plan, elevation and 3-D views to verify the model.

Draw Model


Start
Use Draw Model Tool Palette
Establish Initial Layout Defaults
Ground Plane
Size: 100' x 100'
Spacing: 20' x 20'
√ Show Ground Plane
Units
Increment: 4"
Display: US ft-In
√ Snap To Units
Initial Shape Size
N-S: 73'8"
E-W: 85'8"
Height: 14'0"
Plane Thickness: 10"
Orientation: N-S
√ Stack On Ground Plane
Draw Building Volume
Draw First Floor Volume
Position Cube On Ground Plane
Double Click Right Mouse Key To End
Draw Second Floor Volume
√ Stack On Last Shape
Place Cube On Last Shape
Drag Plane To Correct Dimension
E-W: 49'8"
Draw Gable Roof Volume
Place Prism On Last Shape
√ Lock N-S & E-W
Drag Edge To Correct Roof Slope
Slope: 5.8 In 12

Draw Building Volume

Draw Gable Roof Volume

Unlock N-S & E-W

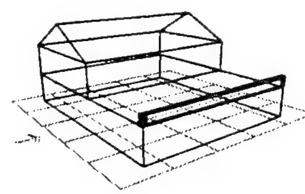
Draw Parapet Walls

Initial Shape Size

Height: 4'0"

✓ Stack On Plane

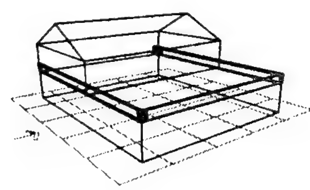
Position Vertical Plane On Roof



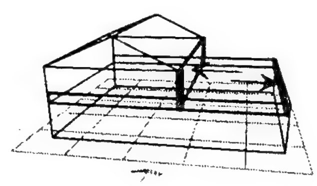
Initial Shape Size

Orientation: E-W

Position Vertical Planes On Roof

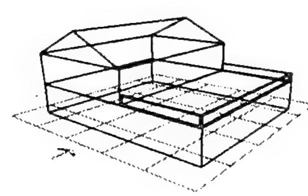


Rotate View To Select Both Slice Planes



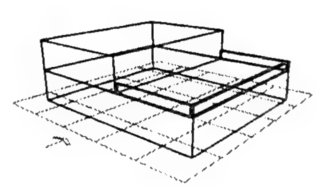
Slice Both E-W Vertical Planes

Delete 4 Unwanted Sliced Shapes



Remove Gable Roof Volume

Delete Prism Shape



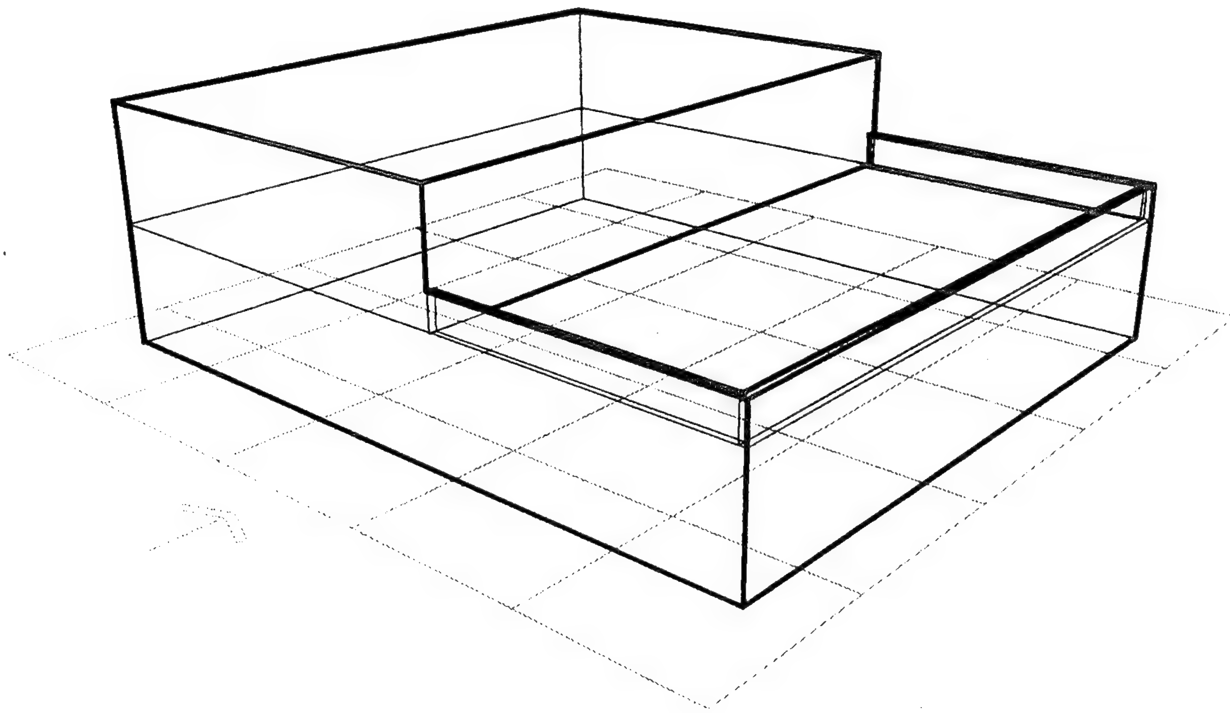
Check Building Volume

Tape Measure

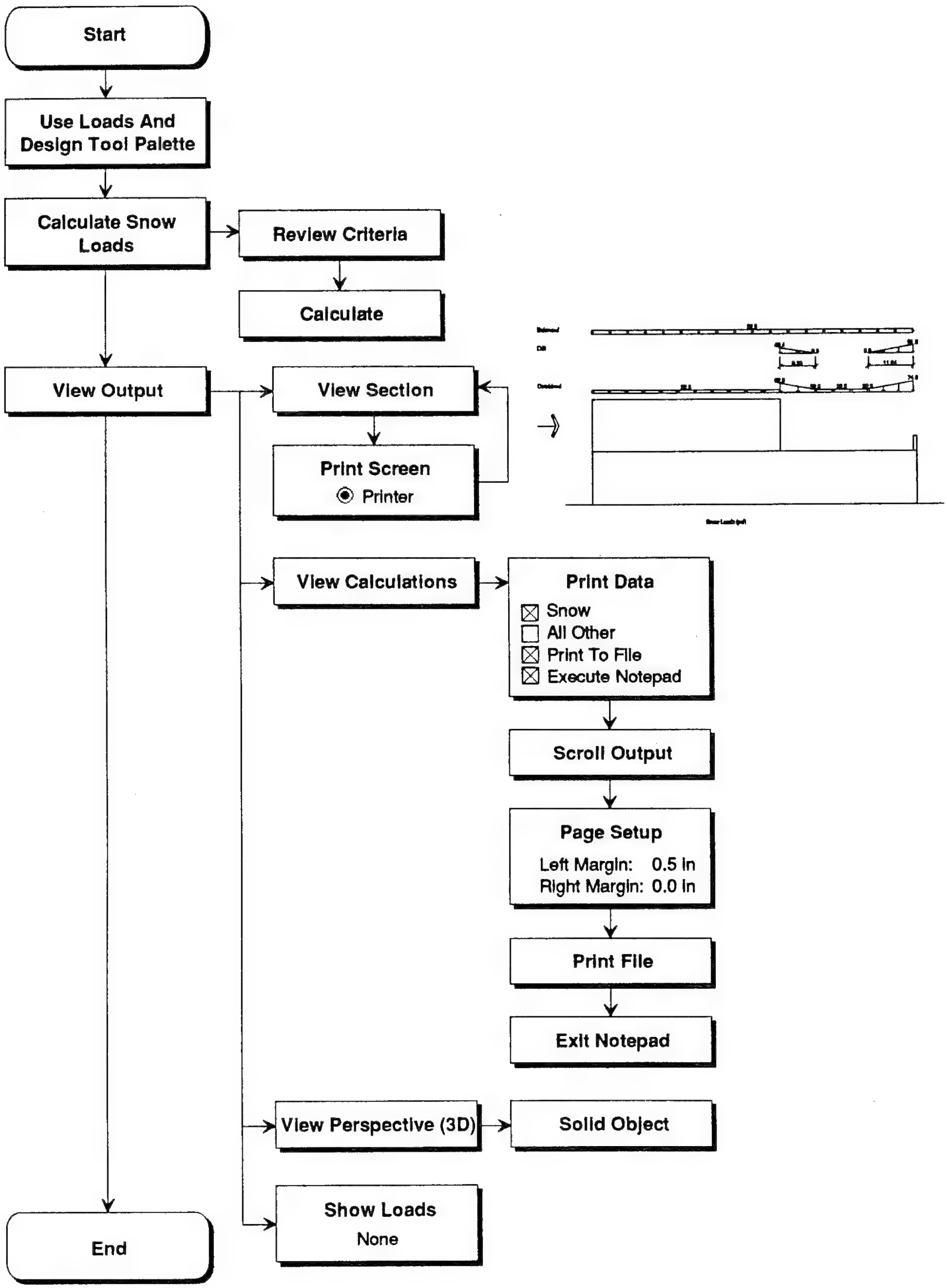
Plan, Elevation And Section

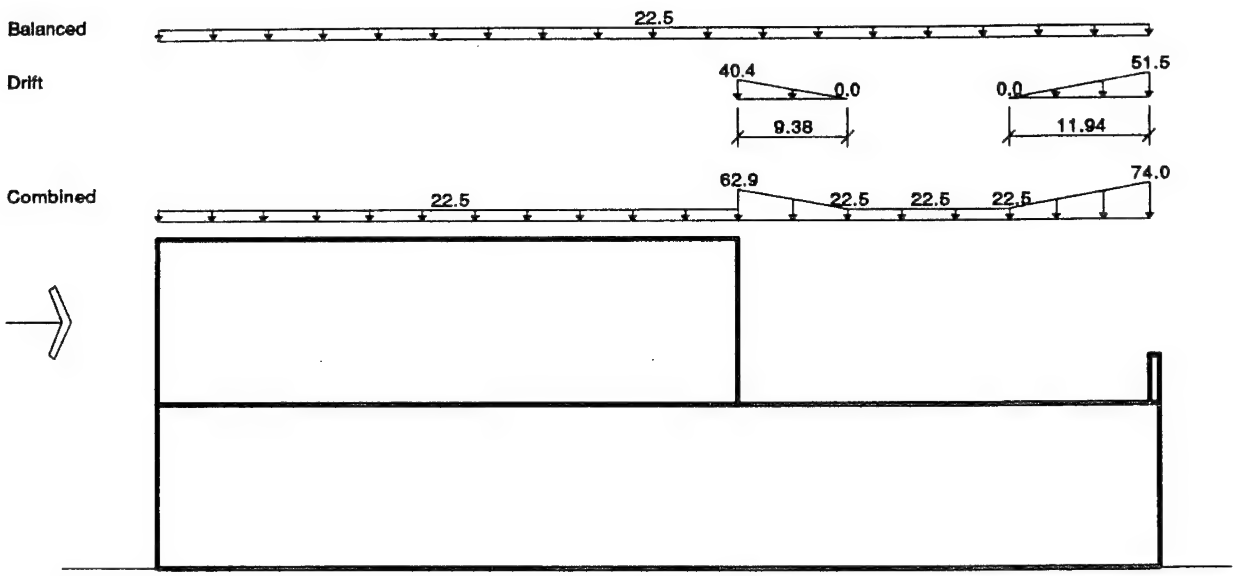
Zoom And Pan

End

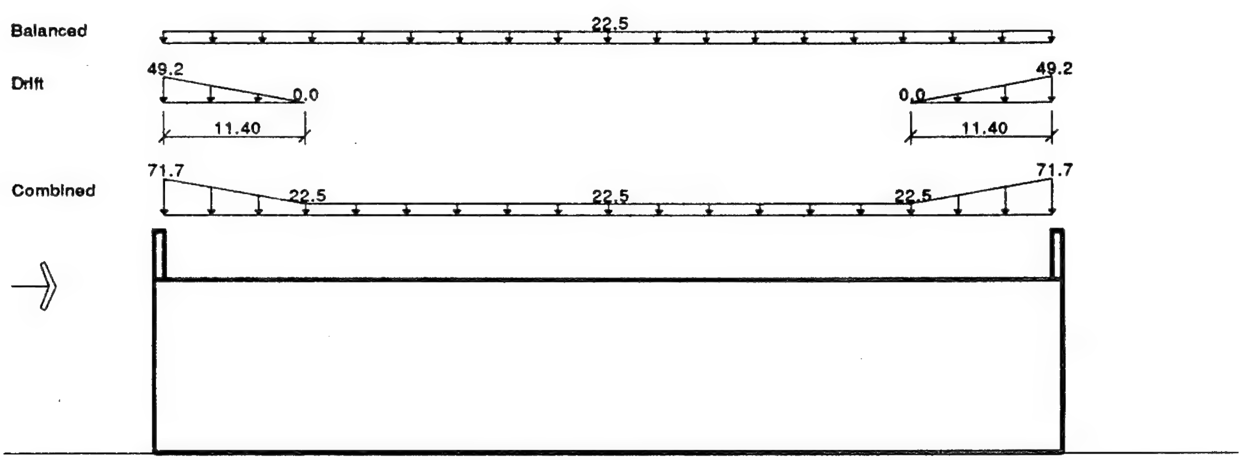


Snow Loads


Start
Use Loads And Design Tool Palette
Calculate Snow Loads
Review Criteria
Calculate
View Output
View Section
Print Screen
Printer
View Calculations
Print Data
Snow
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
None
End



Snow Loads (psf)



Snow Loads (psf)

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Mon Aug 29, 1994  2:55 PM

******************* Flat/Lean-To Roof Snow Load Design *******************

Flat Roof Snow Load (Pf)
Pf = 0.7*Ce*Ct*I*Pg
Snow Exposure Category: C
Ce = 1.0
Heated Structure.
Ct = 1.0
Importance Category: I
I  = 1.0
Pg = 25.0 psf
Pf = 17.50 psf
Roof Slope: 0.00 in 12
Theta = 0 deg
Since theta < 0.5 in/ft, 5.0 psf rain-on-snow surcharge applies.
Pf = 22.50 psf
Check minimum Pf where theta <= 15 deg
When Pg > 20.0 psf, min Pf = 20.0*I
Min Pf = 20.00 psf
+-------------------------+
|     Pf = 22.50 psf      |
+-------------------------+

Sloped Roof Snow Load (Ps)
Ps = Cs*Pf
Roof Slippery: No
Cs = 1.00
+-------------------------+
|     Ps = 22.50 psf      |
+-------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 84.83 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 3.10 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 12.38 ft
w = 4*hc = 11.94 ft
+-------------------------+
|      W = 11.94 ft       |
+-------------------------+

hd = hd*(20.0-s)/20.0 = 3.10 ft
hd > hc, therefore hd = hc = 2.99 ft
Pd = hd*density
```

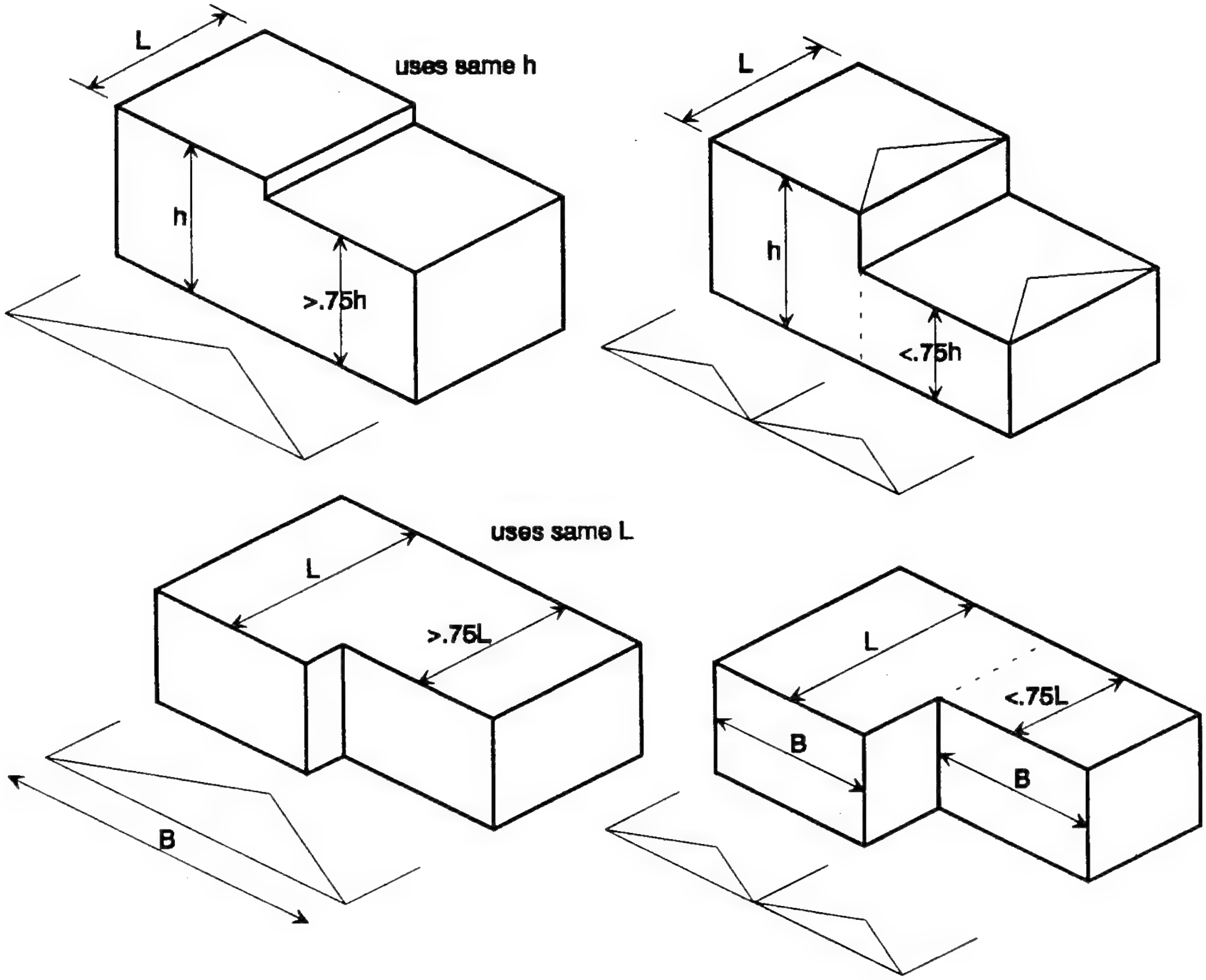
```
+------------------------+
|     Pd = 51.50 psf     |
+------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 72.00 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.85 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 11.40 ft
w = 4*hc = 11.94 ft
+------------------------+
|      W = 11.40 ft      |
+------------------------+

hd = hd*(20.0-s)/20.0 = 2.85 ft
hd <= hc
Pd = hd*density
+------------------------+
|     Pd = 49.18 psf     |
+------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 14.00 ft
hc = height-hb
hc = 12.99 ft
hc/hb = 12.80 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 49.67 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.34 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 9.38 ft
w = 4*hc = 51.94 ft
+------------------------+
|      W = 9.38 ft       |
+------------------------+

hd = hd*(20.0-s)/20.0 = 2.34 ft
hd <= hc
```

```
Pd = hd*density
+-------------------------+
|     Pd = 40.44 psf      |
+-------------------------+
```

Wind Assumptions

Proportions For B/L & h/L

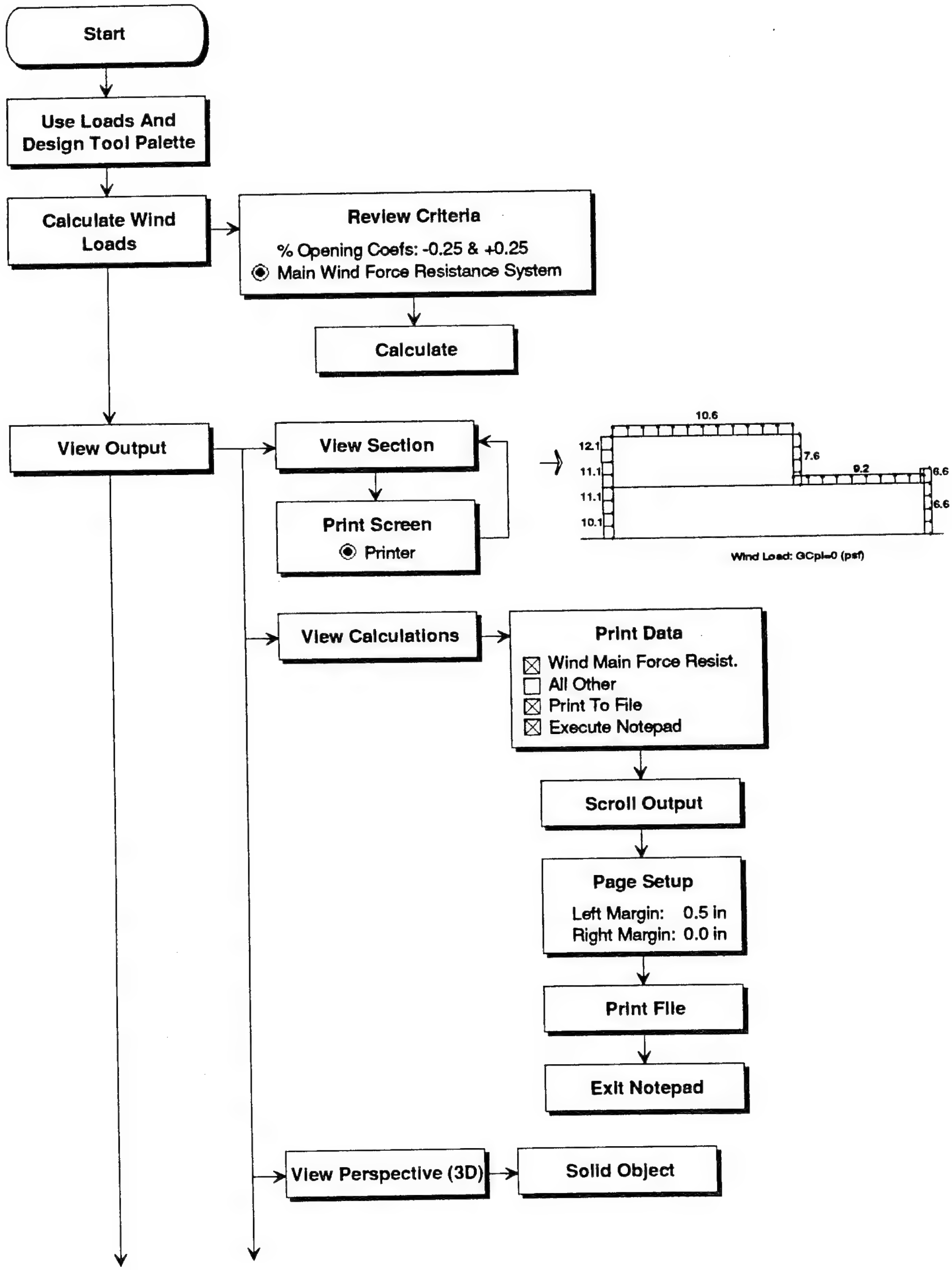
Defaults:	Height Ratio:	0.75
	Plan Ratio:	0.75

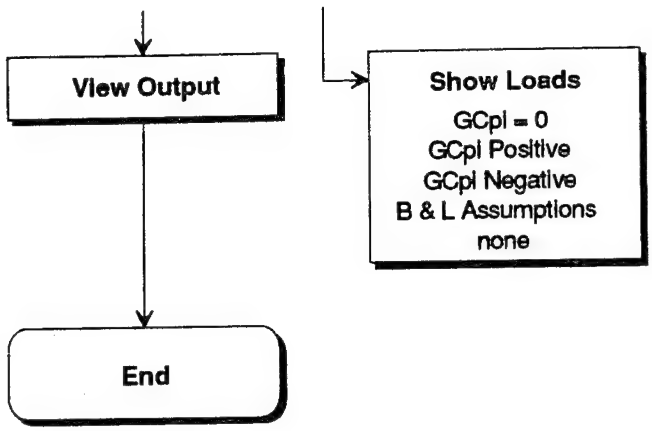


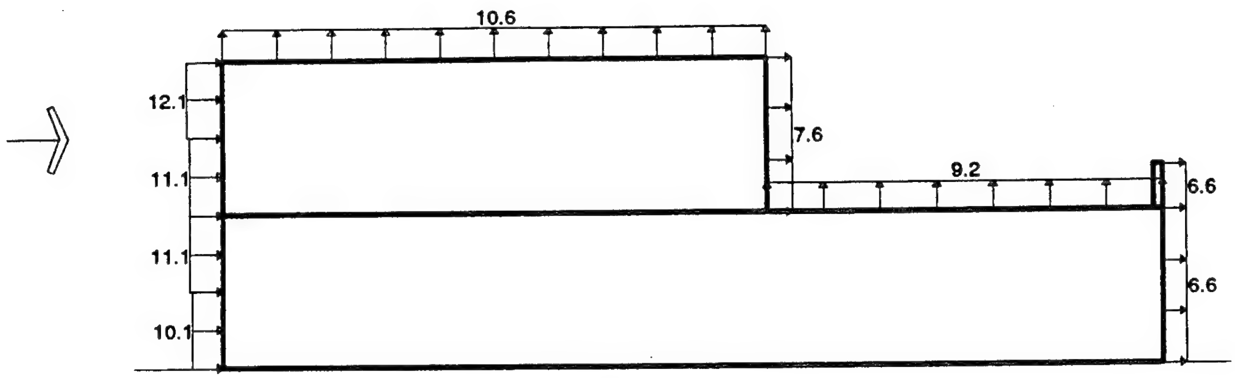
Building Height Maximum 60 Feet

Assumed for components and cladding

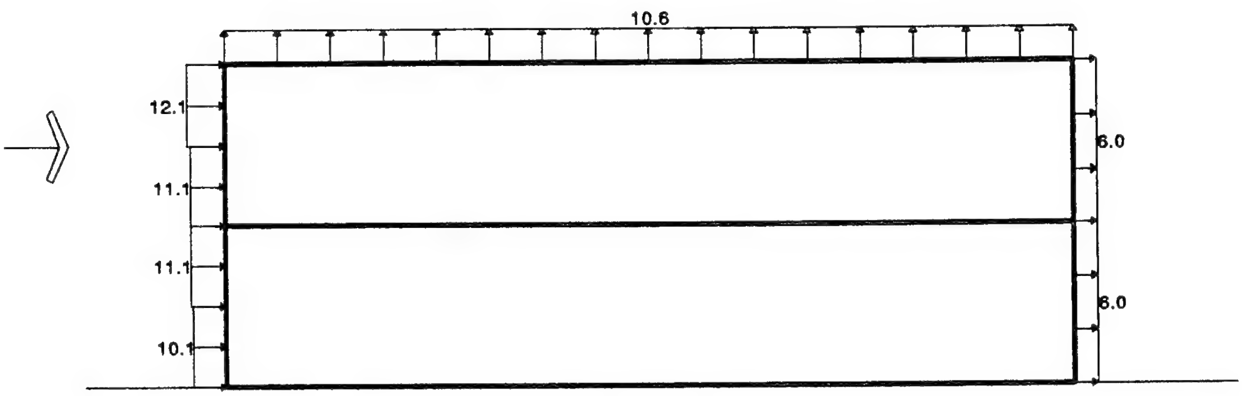
Main Wind Force Resisting Loads



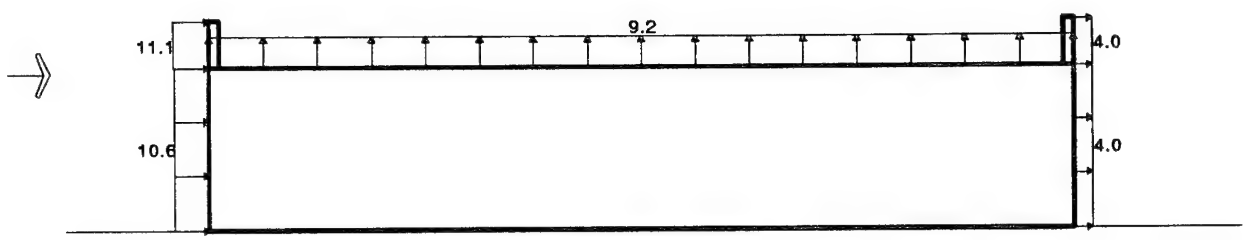

View Output
Show Loads
GCpi = 0
GCpi Positive
GCpi Negative
B & L Assumptions
none
End



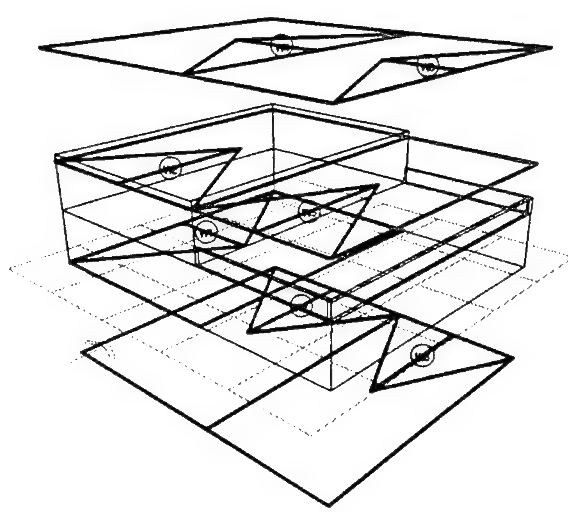
Wind Loads: GCpi=0 (psf)



Wind Loads: GCpi=0 (psf)



Wind Loads: GCpi=0 (psf)



```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load : TM 5-809-1 1992
Time         : Mon Aug 29, 1994   4:13 PM
```

****************************** Wind Load - 1 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	49.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

****************************** Wind Load - 2 ******************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	49.7	73.7	

Distance to ocean line >= 100 mi   h/d = 0.56 <= 5

************************* Main Framing Pressures *************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.40	-6.0	-3.0	-9.0
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

```
******************************** Wind Load - 3 ********************************

Velocity  Importance  Exposure    Width      Length               Roof Type
            Factor              Perpend.   Parallel
                                to Wind    to Wind
  (mph)                          (ft)       (ft)
-----------------------------------------------------------------------------
  70.0       1.00         C       73.7       36.0

Distance to ocean line >= 100 mi    h/d = 0.39 <= 5

************************* Main Framing Pressures *************************

                        Parallel to Ridge or Length
-----------------------------------------------------------------------------
Location             z or h   Gh     Kz     qz     Cp   External Pressure P (psf)
                      (ft)                 (psf)         GCpi=0   -0.25     0.25
-----------------------------------------------------------------------------
Windward Wall
  parapet             18.0   1.32   0.84   10.5   0.80    11.1
  level  1            14.0   1.32   0.80   10.0   0.80    10.6     13.1      8.1
  level  1             0.0   1.32   0.80   10.0   0.80    10.6     13.1      8.1
Leeward Wall          14.0   1.32   0.80   10.0  -0.50    -6.6     -4.1     -9.1
Side Wall             14.0   1.32   0.80   10.0  -0.70    -9.2     -6.7    -11.7
Roof                  14.0   1.32   0.80   10.0  -0.70    -9.2     -6.7    -11.7
Overhang **           14.0          0.80   10.0   0.80     8.0
Internal              14.0          0.80   10.0            0.0     -2.5      2.5

****************************** Wind Load - 4 ******************************

Velocity  Importance  Exposure    Width      Length               Roof Type
            Factor              Perpend.   Parallel
                                to Wind    to Wind
  (mph)                          (ft)       (ft)
-----------------------------------------------------------------------------
  70.0       1.00         C       73.7       49.7

Distance to ocean line >= 100 mi    h/d = 0.56 <= 5

************************* Main Framing Pressures *************************

                        Parallel to Ridge or Length
-----------------------------------------------------------------------------
Location             z or h   Gh     Kz     qz     Cp   External Pressure P (psf)
                      (ft)                 (psf)         GCpi=0   -0.25     0.25
-----------------------------------------------------------------------------
Windward Wall
  level  2            28.0   1.26   0.96   12.0   0.80    12.1     15.1      9.1
  level  1 - 2        14.0   1.26   0.80   10.0   0.80    10.1     13.1      7.1
  level  1             0.0   1.26   0.80   10.0   0.80    10.1     13.1      7.1
Leeward Wall          28.0   1.26   0.96   12.0  -0.50    -7.6     -4.6    -10.6
Side Wall             28.0   1.26   0.96   12.0  -0.70   -10.6     -7.6    -13.6
Roof                  28.0   1.26   0.96   12.0  -0.70   -10.6     -7.6    -13.6
Overhang **           28.0          0.96   12.0   0.80     9.6
Internal              28.0          0.96   12.0            0.0     -3.0      3.0

****************************** Wind Load - 5 ******************************

Velocity  Importance  Exposure    Width      Length               Roof Type
            Factor              Perpend.   Parallel
                                to Wind    to Wind
  (mph)                          (ft)       (ft)
-----------------------------------------------------------------------------
  70.0       1.00         C       36.0       73.7

Distance to ocean line >= 100 mi    h/d = 0.39 <= 5
```

************************** Main Framing Pressures **************************

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.30	-4.0	-1.5	-6.5
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

Notes for main framing:

Positive pressures act toward surfaces.

Pressure or suction = P = q*Gh*Cp-qh*(GCpi)

q: qz for windward wall evaluated at height z.

qh for leeward wall, side walls, and roof evaluated at mean roof height.

** For roof overhangs: algebraically add this pressure to the above values. P = qh(GCp) = 0.8qh

Internal Pressure Coefficients for Buildings, GCpi:

	Condition	GCpi
Condition I	All conditions except as noted under condition II.	+0.25 -0.25
Condition II	Buildings in which both of the following are met: 1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and 2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	+0.75 -0.25

Notes:

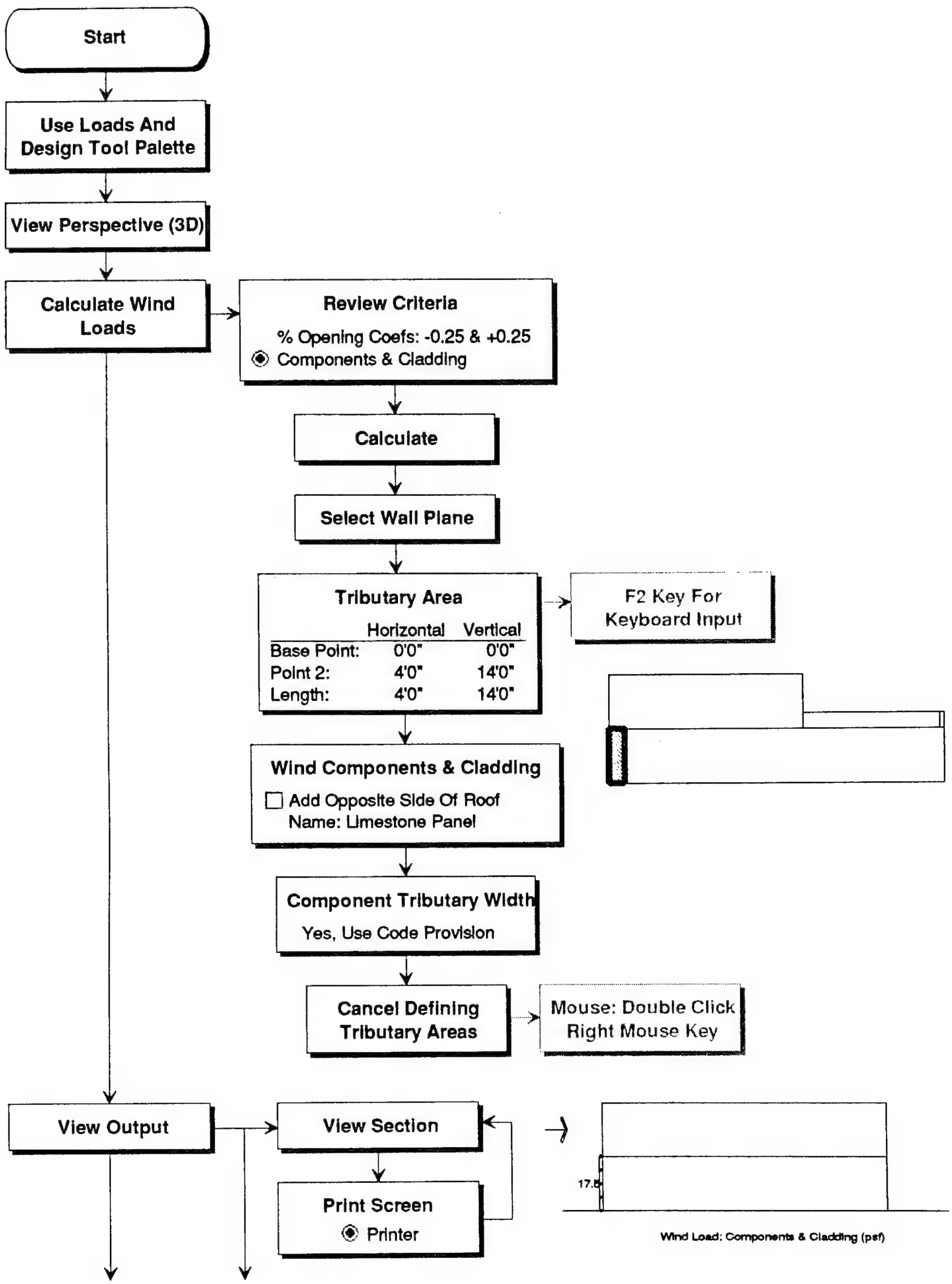
(1) Values are to be used with qz or qh as specified in Table 4.

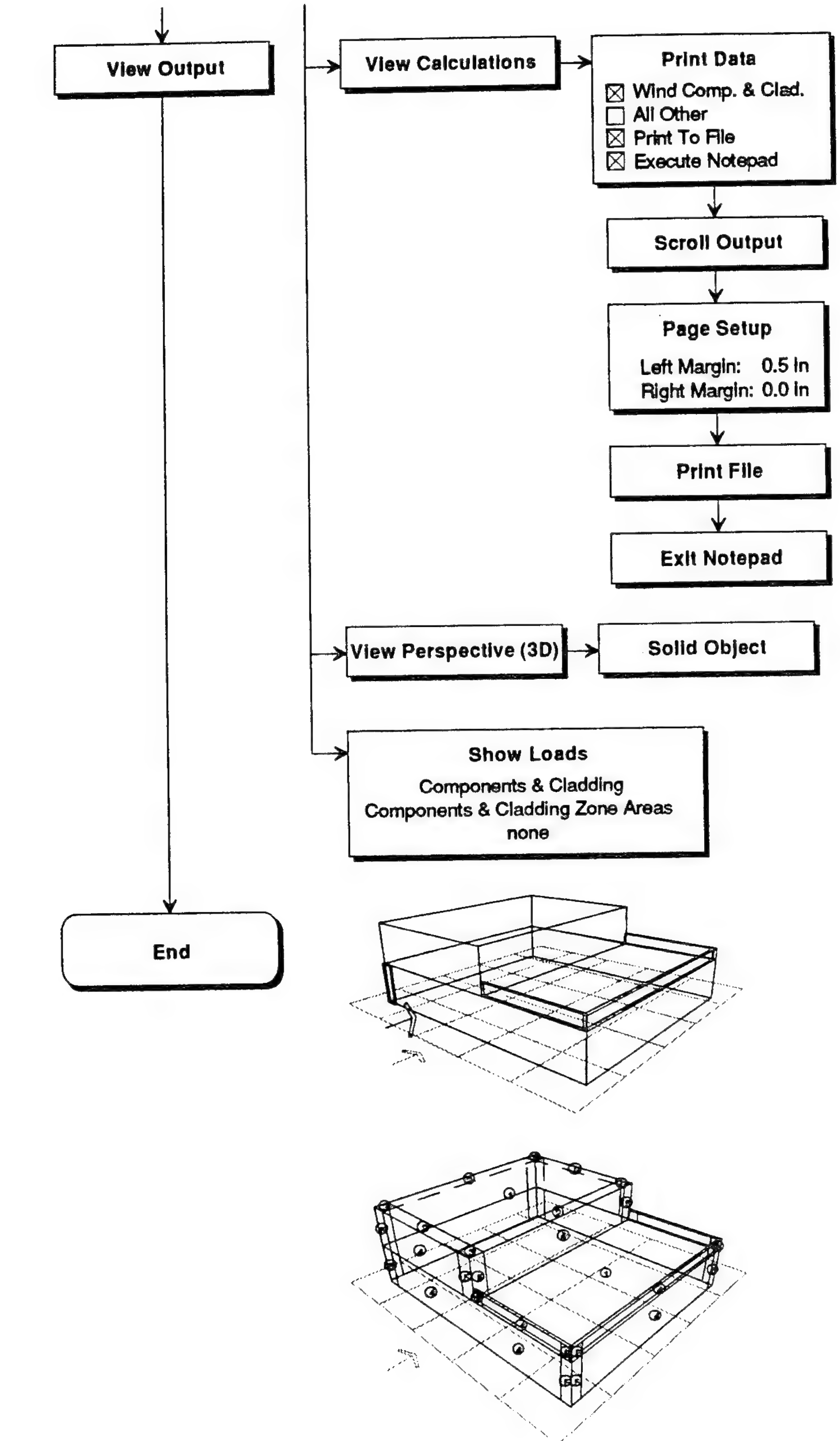
(2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.

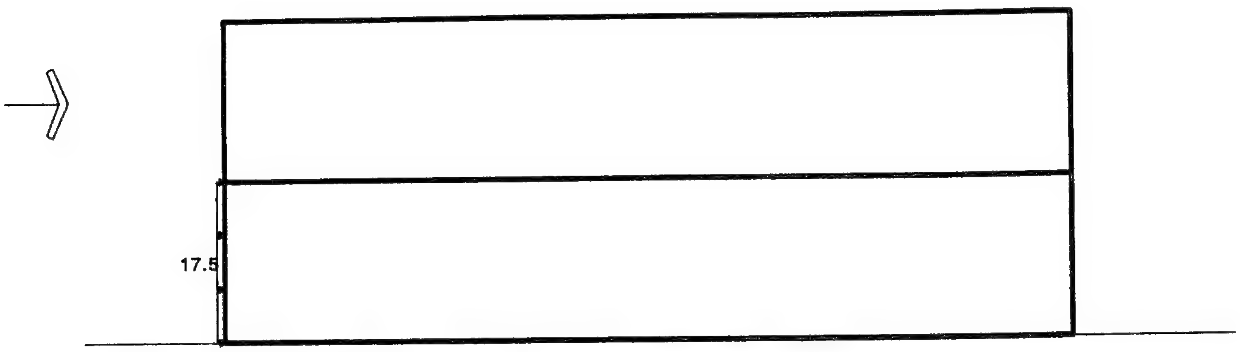
(3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCpi applied simultaneously to all surfaces, and a negative value of GCpi applied to all surfaces.

(4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

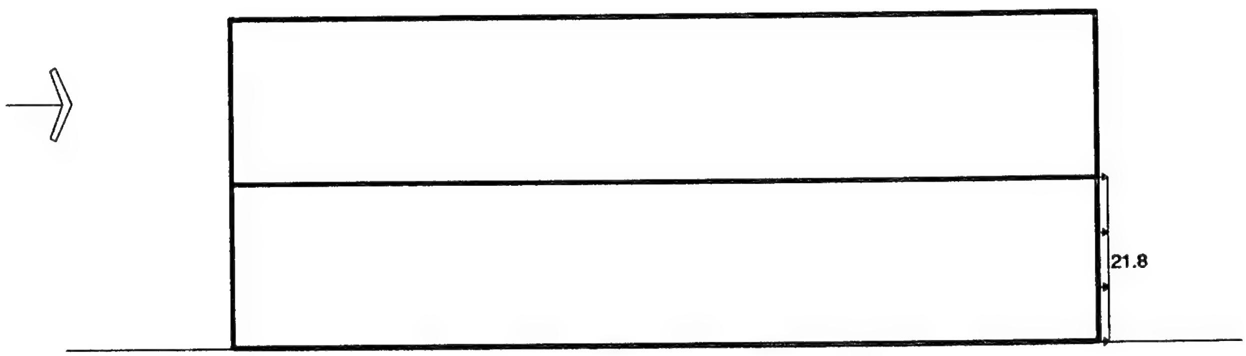
Wind Components & Cladding Loads



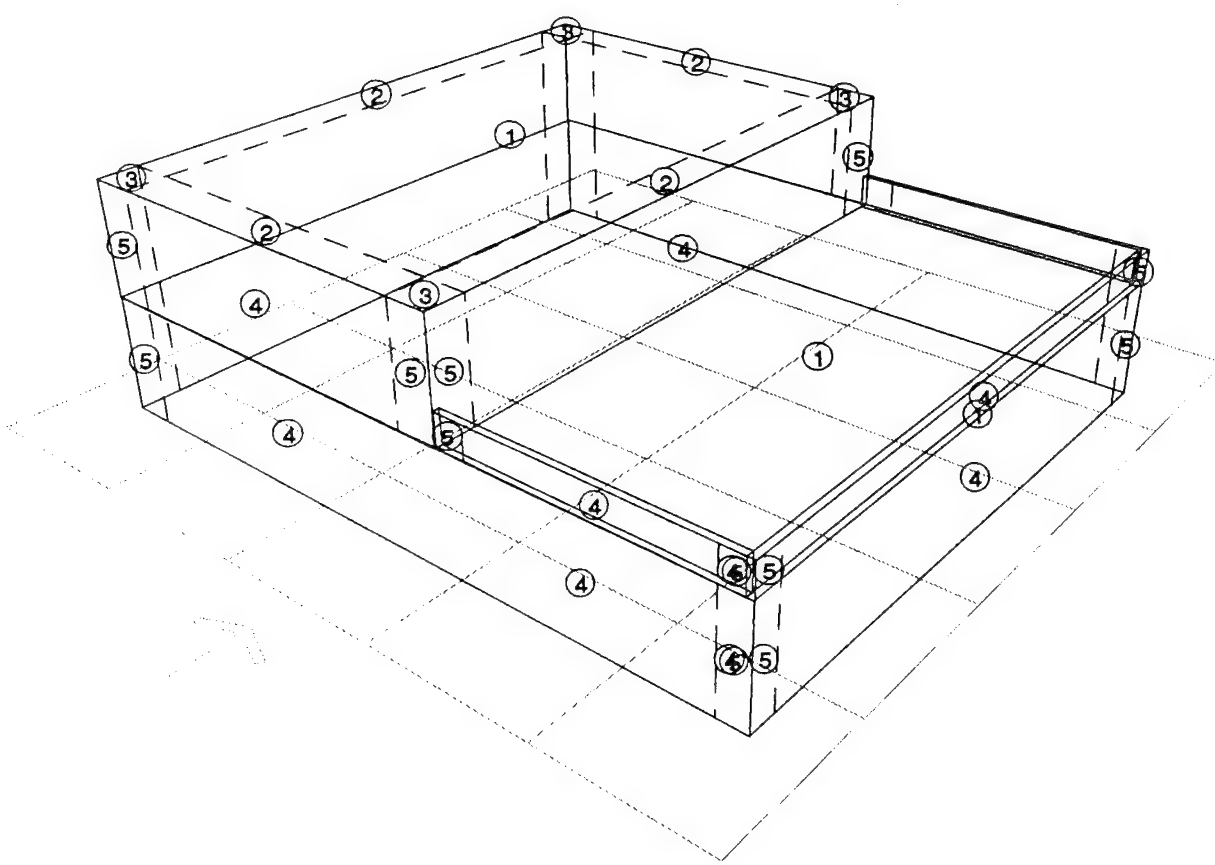

View Output
View Calculations
Print Data
Wind Comp. & Clad.
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
Components & Cladding
Components & Cladding Zone Areas
none
End



Wind Loads: Components & Cladding (psf)



Wind Loads: Components & Cladding (psf)



Project : Office Building - Scheme A
Location : Radford AAP
Design Load : TM 5-809-1 1992
Time : Mon Aug 29, 1994 4:32 PM

******************************** Wind Load ********************************

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	49.7	73.7	

Distance to ocean line >= 100 mi h/d = 0.56 <= 5

Height (ft)	Kh	qh (psf)	GCpi	
28.0	0.96	12.0	-0.25	0.25

Height <= 60.0 ft

****************** Component/Cladding Pressures (psf) *******************

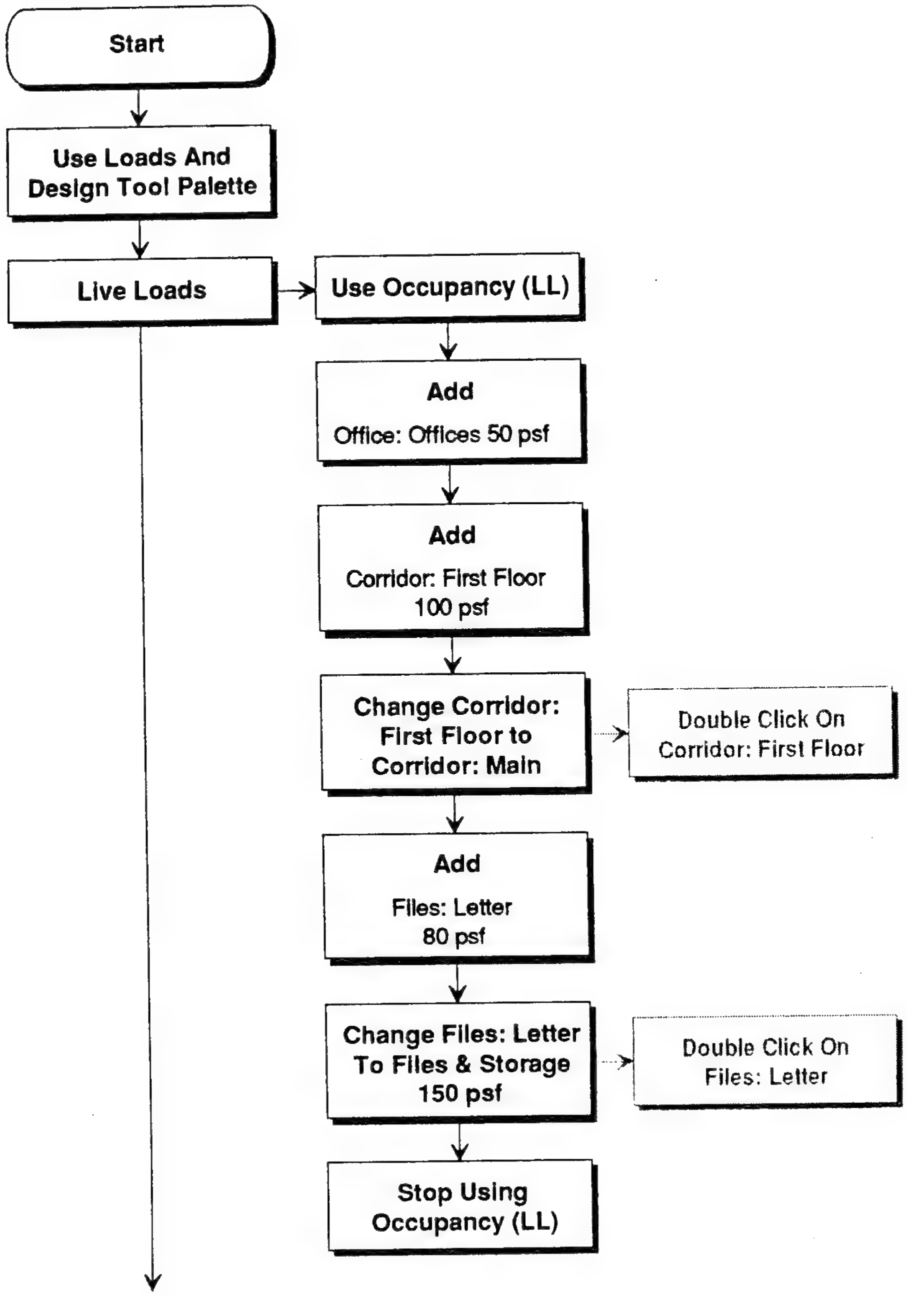
	Walls							
	Windward				Leeward			
Tributary Area (sf)	Zone 4 middles		Zone 5 corners		Zone 4 middles		Zone 5 corners	
	GCp	P	GCp	P	GCp	P	GCp	P
Internal		-3.0		-3.0		3.0		3.0
Limestone Panel 4.67 ft x 14.00 ft **								
65.3	1.21	17.5	1.21	17.5	-1.31	-18.7	-1.57	-21.8
				a = 5.0 ft				

Notes for components and cladding:
P = qh(GCp)-qh(GCpi)
Internal pressures have been included in above values.
To comply with TM 5-809-1, wall external pressures have not been reduced 10% per ASCE figure 3, note 3.
** For a rectangular tributary area, the width of the area need not be less than one-third the length of the area.
Internal Pressure Coefficients for Buildings, GCpi:

	Condition	GCpi
Condition I	All conditions except as noted under condition II.	+0.25 -0.25
Condition II	Buildings in which both of the following are met: 1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and 2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	+0.75 -0.25

Notes:
(1) Values are to be used with qz or qh as specified in Table 4.
(2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
(3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCpi applied simultaneously to all surfaces, and a negative value of GCpi applied to all surfaces.
(4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

Dead & Live Loads



Dead Loads → **Floor Dead Loads** → **Use Floor (DL)**

Input

Name:	Second Floor	
	Type	psf
Partition:	51-100 plf	6.0
Finish:	Carpet & Pad	1.0
Deck:	MTL DK 2.0/NLWT 2.5	42.0
Structure:	Steel Beams	0.0
Mechanical:	Mech A/C Ducts	3.0
Electrical:	Elect/Lighting	1.0
Fire Protection:	Sprinklers Wet	2.0
Ceiling:	Susp Chnl/Tile	2.0
Total:		57.0

→ **Select Type Button** → **Scroll To Find Load Type & PSF** → **Double Click On Load Type**

Stop Using Floor (DL)

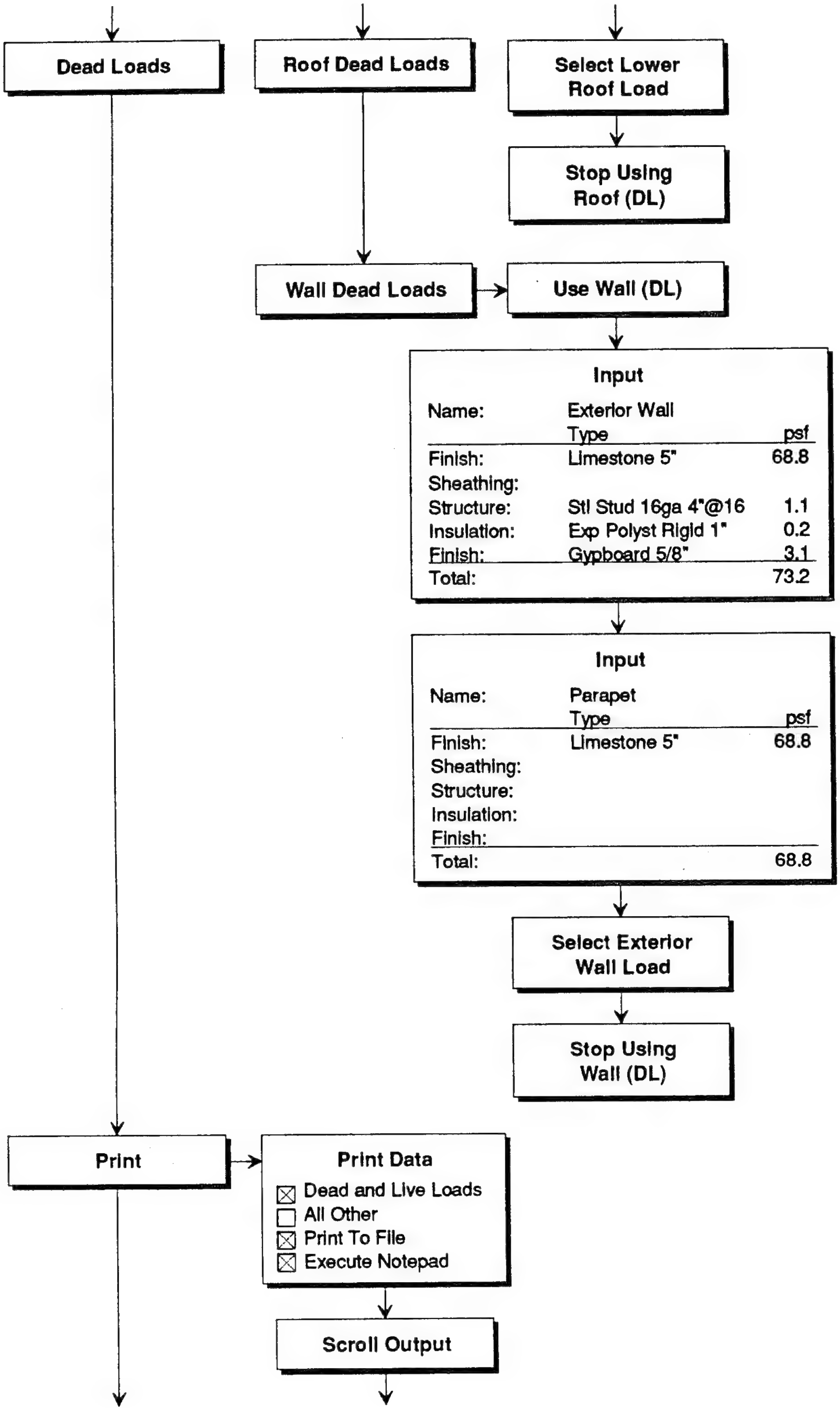
Roof Dead Loads → **Use Roof (DL)**

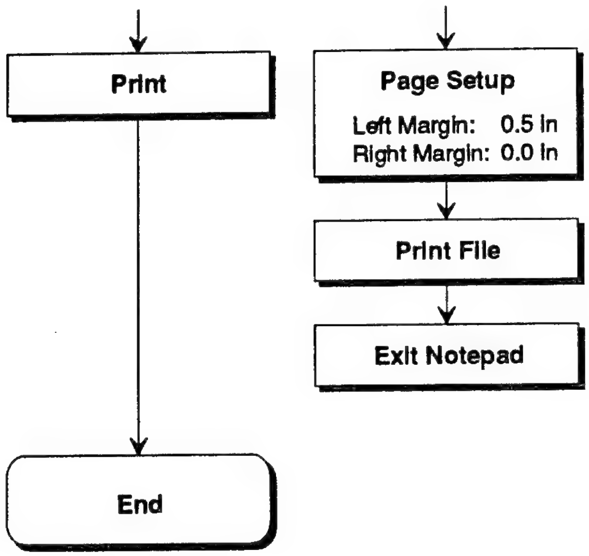
Input

Name:	Lower Roof	
	Type	psf
Roofing:	Single Ply	1.5
Deck:	MTL DK 1.5/NLWT 2.5	36.0
Structure:	Steel Bar Jst 24'@4'	1.8
Mechanical:	Mech A/C Ducts	3.0
Electrical:	Elect/Lighting	1.0
Fire Protection:	Sprinklers Wet	2.0
Insulation:	Rigid Roof Ins 3"	2.4
Ceiling:		
Total:		47.7

Input

Name:	Upper Roof	
	Type	psf
Roofing:	Single Ply	1.5
Deck:	Steel 1-1/2" 20ga	2.5
Structure:	Steel Beams	0.0
Mechanical:	Mech A/C Ducts	3.0
Electrical:	Elect/Lighting	1.0
Fire Protection:	Sprinklers Wet	2.0
Insulation:	Rigid Roof Ins 3"	2.4
Ceiling:	Susp Chnl/Tile	2.0
Total:		14.4


Dead Loads
Roof Dead Loads
Select Lower Roof Load
Stop Using Roof (DL)
Wall Dead Loads
Use Wall (DL)
Input
Name: Exterior Wall
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure: Stl Stud 16ga 4"@16 1.1
Insulation: Exp Polyst Rigid 1" 0.2
Finish: Gypboard 5/8" 3.1
Total: 73.2
Input
Name: Parapet
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure:
Insulation:
Finish:
Total: 68.8
Select Exterior Wall Load
Stop Using Wall (DL)
Print
Print Data
☒ Dead and Live Loads
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output


Print
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Loads

Floor Dead Loads

Name : Second Floor

	Type	psf
Partition	: 51-100 plf	6.0
Finish	: Carpet & Pad	1.0
Deck	: MTL DK 2.0/NLWT 2.5	42.0
Structure	: Steel Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Ceiling	: Susp Chnl/Tile	2.0
Total	:	57.0

Roof Dead Loads

Name : Lower Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: MTL DK 1.5/NLWT 2.5	36.0
Structure	: Steel Bar Jst 24'@4'	1.8
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	:	0.0
Total	:	47.7

Name : Upper Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: Steel 1-1/2" 20ga	2.5
Structure	: Steel Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	: Susp Chnl/Tile	2.0
Total	:	14.4

Wall Dead Loads

Name : Exterior Wall

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	: Stl Stud 16ga 4"@16	1.1
Insulation	: Exp Polysty Rigid 1"	0.2
Finish	: Gypboard 5/8"	3.1
Total	:	73.2

Name : Parapet

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	:	0.0
Insulation	:	0.0
Finish	:	0.0
Total	:	68.8

Occupancy Live Loads

Name	psf
Office: Offices	50
Corridor: Main	100
Files & Storage	150 a

a. These design loads are extremely variable. The design load will be increased when data is available.

Notes

Uniformly distributed live loads for supporting members; i.e., two-way slab, beam, girder or columns having an influence area of 400.0 sqft or more may be reduced with: L = Lo*[0.25+(15/sqrt(Ai))]

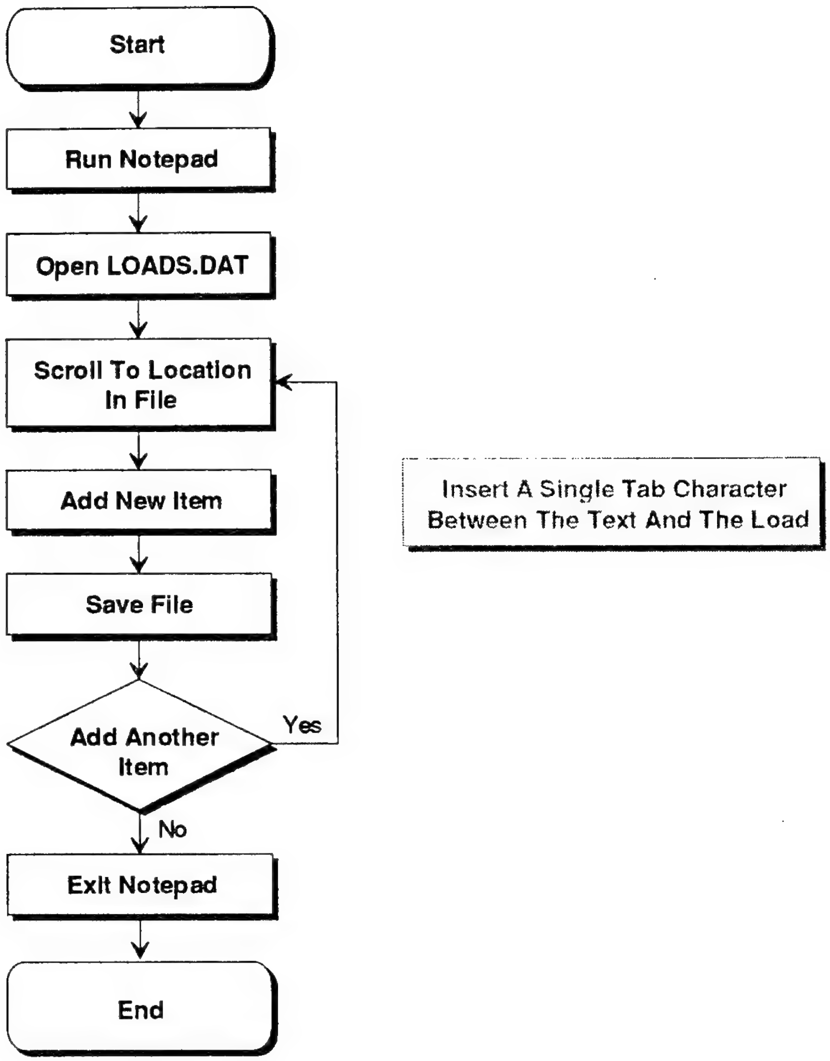
The reduced design live load will not be less than 50% of the unit live load for members supporting one floor, nor less than 40% of the unit live load for members supporting two or more floors.

Exceptions: For live loads less than 100 psf, no reduction is permitted for members supporting floor(s) in the following areas:

- -public assembly
- -garages [except where 2 or more floors are supported]
- -one-way slab floor

For live loads greater than 100 psf and for garages used for passenger cars only, no reduction is permitted for members supporting one floor; however, where two or more floors are supported, a 20% reduction is permitted.

Loads Database



Draw Grid & Openings

Start

Use Draw Structure Tool Palette

Define Structural Grid

Select Second Floor/ Lower Roof Horizontal Structural Plane

Structural Plane Information

Name: Second Floor/Lower Roof

Close Structural Plane Information Dialog Window

Define Grid

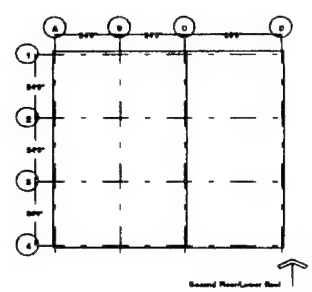
N-S Spacing:	24'0"
E-W Spacing:	24'0"
Perimeter Offset:	10"

Delete Grid Lines D & E

Delete Grid Lines

Select Grid Line E Then D

Double Click Right Mouse Key To End Deleting Grid Lines

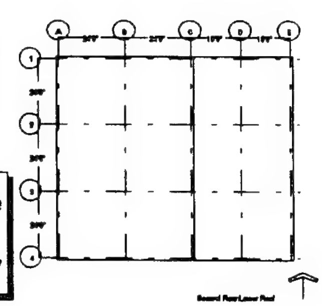


Add Main Grid Line Between C & D

Add Main Grid Line

Select Handle Between C & D

Keep Dimensions To The Left & Right At 18' And Click The Left Mouse Key



Draw Openings

Add Opening

	Horizontal	Vertical
Base Point:	10"	24'10"
Point 2:	8'10"	48'10"
Length:	8'0"	24'0"

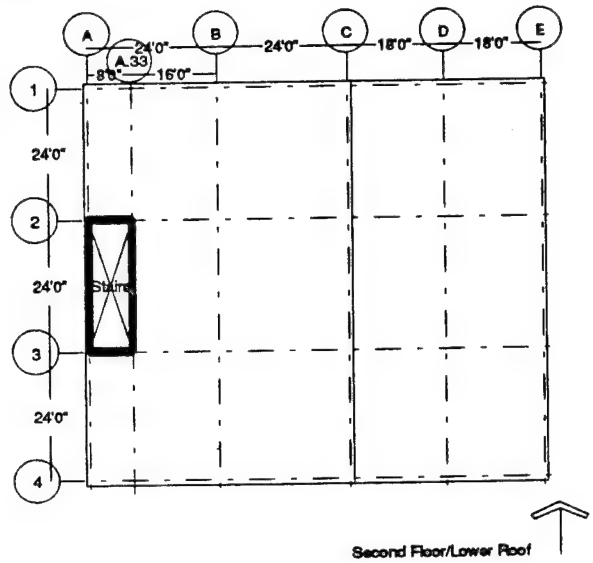
F2 Key For Keyboard Input

Opening

Name: Stairs

☐ Continuous

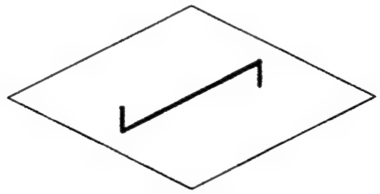
End



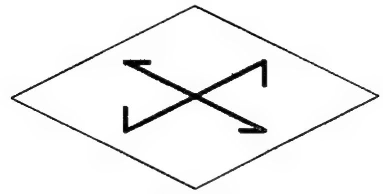
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)



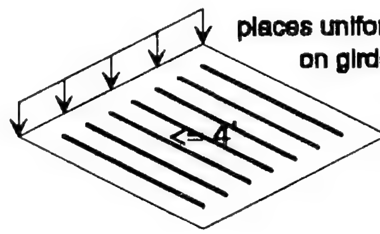
1 way



2 way
(not activated)

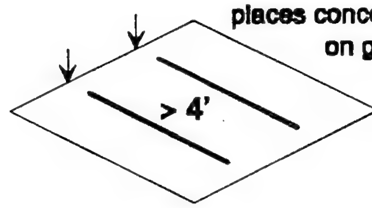
Linear
(horizontal)

Narrowly Spaced
(joists)



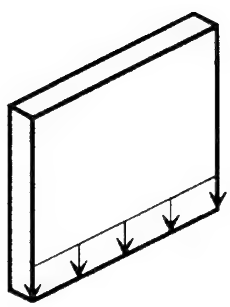
places uniform loads on girders

Widely Spaced
(beams)



places concentrated loads on girders

Surface
(vertical)
(planar)



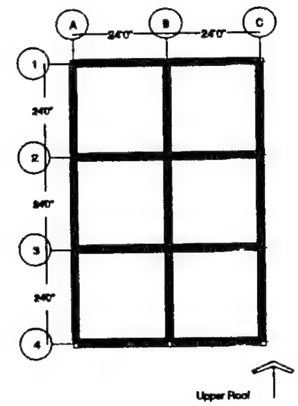
uniform loads

Linear
(vertical)

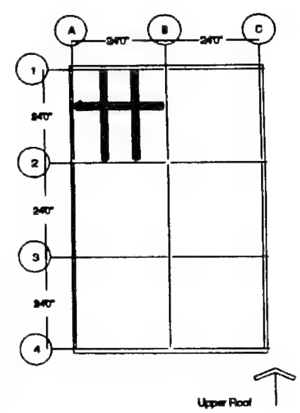
concentrated loads

Draw Structure

- Start
- Use Draw Structure Tool Palette
- Draw Upper Roof Framing
  - Select Upper Roof Horizontal Structural Plane
  - Structural Plane Information
    Name: Upper Roof
  - Close Structural Plane Information Dialog Window
  - Draw Linear Beams On All Grid Lines



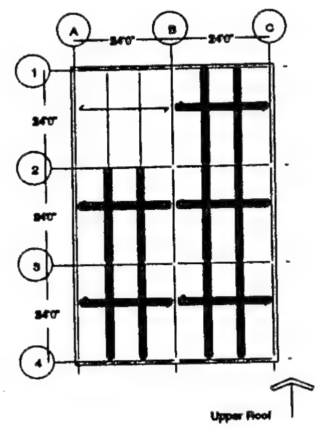
  - Draw Third Point Beams In Bay A1-B2
    - Linear: Widely Spaced
    - Select Handle On Grid A1-B1
    - Select Handle On Grid A2-B2
    - Double Click Right Mouse Key To End Defining Area
    - Save Linear Elements
      Orientation: N-S
      ◉ Number Of Elements: 2
      ☒ Draw Surface



Draw Upper Roof framing

Copy Beams & One-Way Surface To Other Bays → Copy Structure

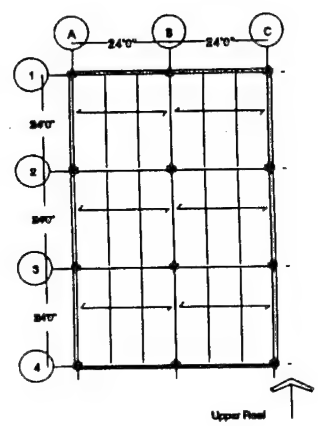
Copy Structure → Select Third Point Beams → Select One-Way Surface → Double Click Right Mouse Key To End Selecting Structure → Select Grid Location A1 As The Base Point → Paste Structure → Select Grid Locations B1, A2, B2, A3, B3 → Double Click Right Mouse Key To End



Draw Columns → Column All Grid Intersections → Save Column Elements

Orientation: N-S

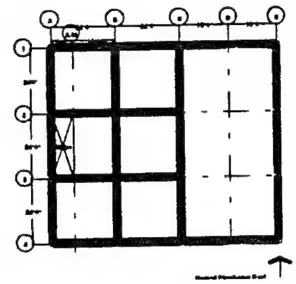
☒ All Floors



Draw Second Floor/ Lower Roof Framing → Select Second Floor/ Lower Roof Horizontal Structural Plane → Draw Linear Beams On All Grid Lines

Draw Second Floor/ Lower Roof Framing

Delete Beams At Grid Locations Inside C1-E4

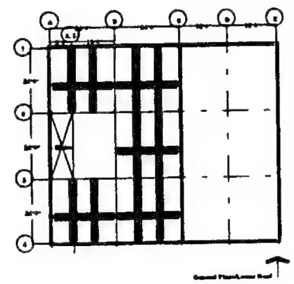


Draw Third Point Beams And One-Way Surface In Bays A1-B2, B1-C2, B2-C3, A3-B4, B3-C4

Paste Structure

Select Grid Locations A1, B1, B2, A3, B3

Double Click Right Mouse Key To End



Draw Third Point Beams In Bay A2-B3

Linear: Widely Spaced

Select Handle On Grid B2-B3

Select Handle On Grid A2-A3

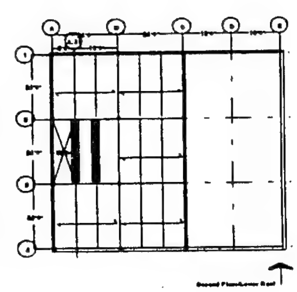
Double Click Right Mouse Key To End Defining Area

Save Linear Elements

Orientation: N-S

◉ Number Of Elements: 2

☐ Draw Surface



Draw Surface In Bay A.33,2-B3

Surface: One-Way

Select Handle On Grid A.33,2-A.33,3

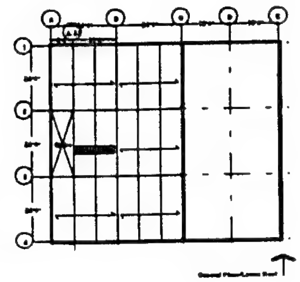
Select Handle On Grid Line B2-B3

Draw Second Floor/ Lower Roof Framing

Draw Surface In Bay A.33,2-B3

Double Click Right Mouse Key To End Defining Area

Save Surface Element
Orientation: E-W



Draw Joists In Bay C1-E2

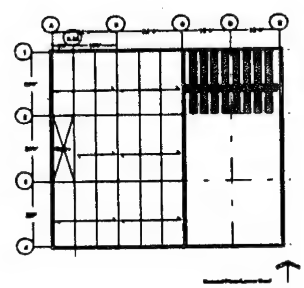
Linear: Narrowly Spaced

Select Handle On Grid C1-C2

Select Handle On Grid E1-E2

Double Click Right Mouse Key To End Defining Area

Save Linear Elements
Orientation: N-S
◉ Spacing: 48"
☒ Draw Surface



Copy Joists & One-Way Surface To Other Bays

Copy Structure

Select Joists

Select One-Way Surface

Double Click Right Mouse Key To End Selecting Structure

Draw Second Floor/ Lower Roof Framing

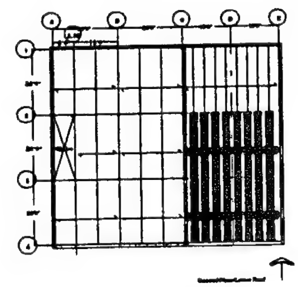
Copy Joists & One-Way Surface To Other Bays

Select Grid Location C1 As The Base Point

Paste Structure

Select Grid Locations C2, C3

Double Click Right Mouse Key To End



Draw Trusses

Linear Truss-Custom

Select Grid Locations C2-D2, D2-E2

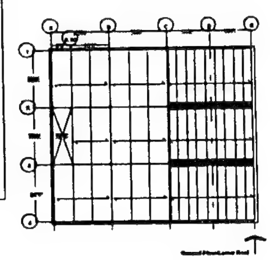
Double Click Right Mouse Key To End Defining Area

Save Linear Elements
Orientation: E-W

Truss-Custom

- ☐ Include Opposite Side Of Roof
- Depth Of Support: 3'
- Scissors Height: 0'

Repeat For Grid Location C3-E3



Draw Columns

Column One Grid Intersection

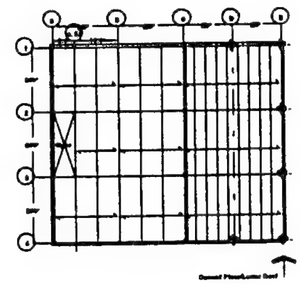
Select Grid Locations D1, E1, E2, E3, D4, E4

Draw Second Floor/ Lower Roof Framing

Draw Columns

Double Click Right Mouse Key To End Selecting Locations

Save Columns
Orientation: N-S
Height: 14'
☐ All Floors



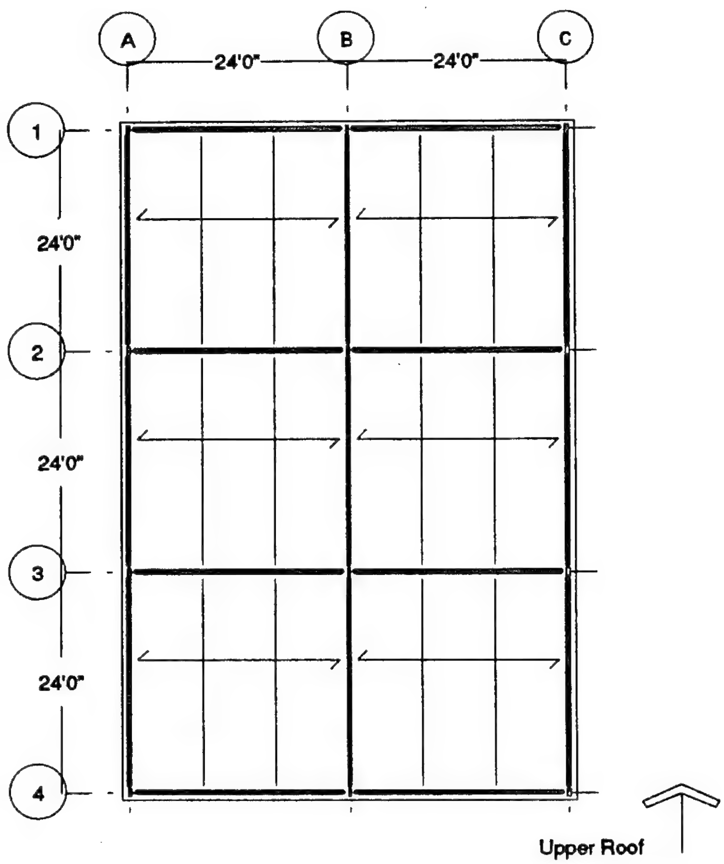
View Structure

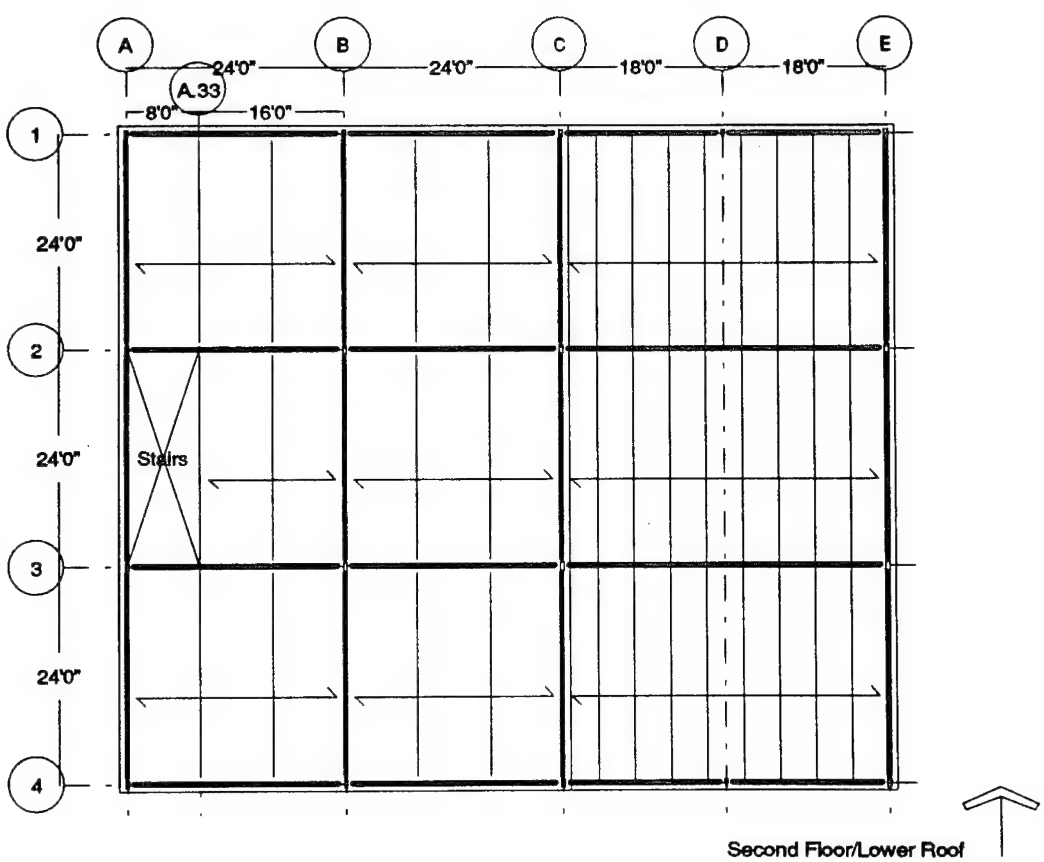
Show Structure
☒ All Planes

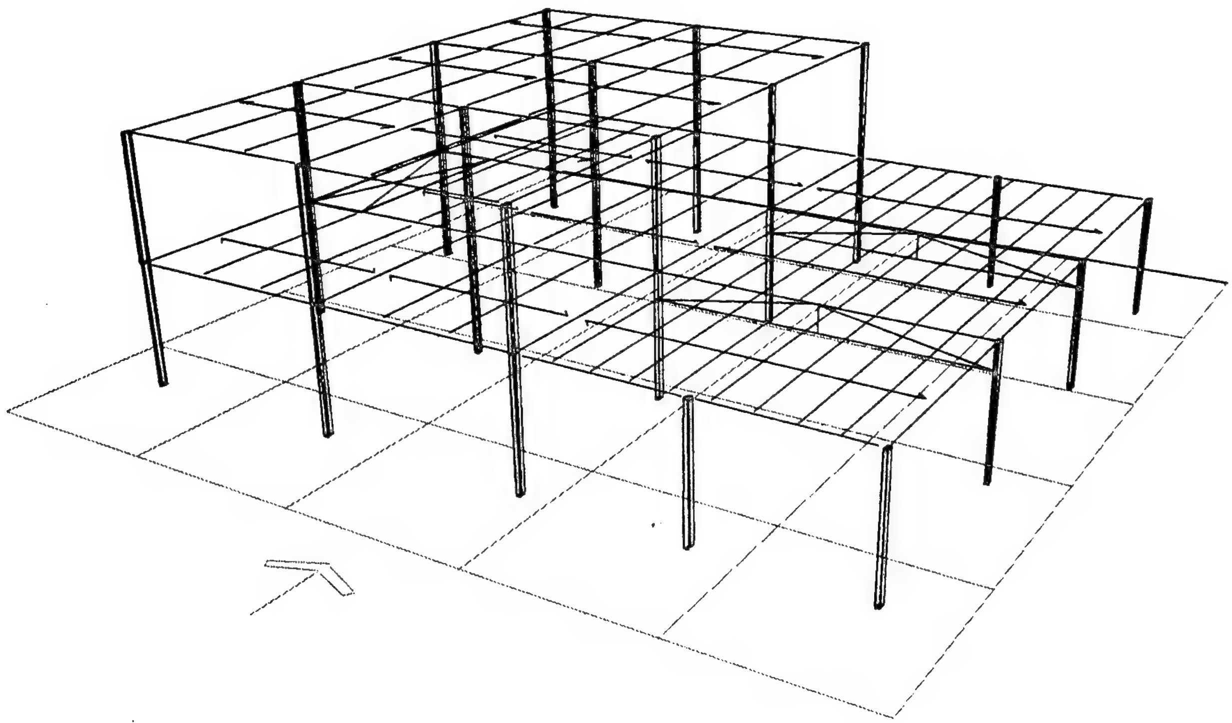
Perspective (3D)

Transparent Object

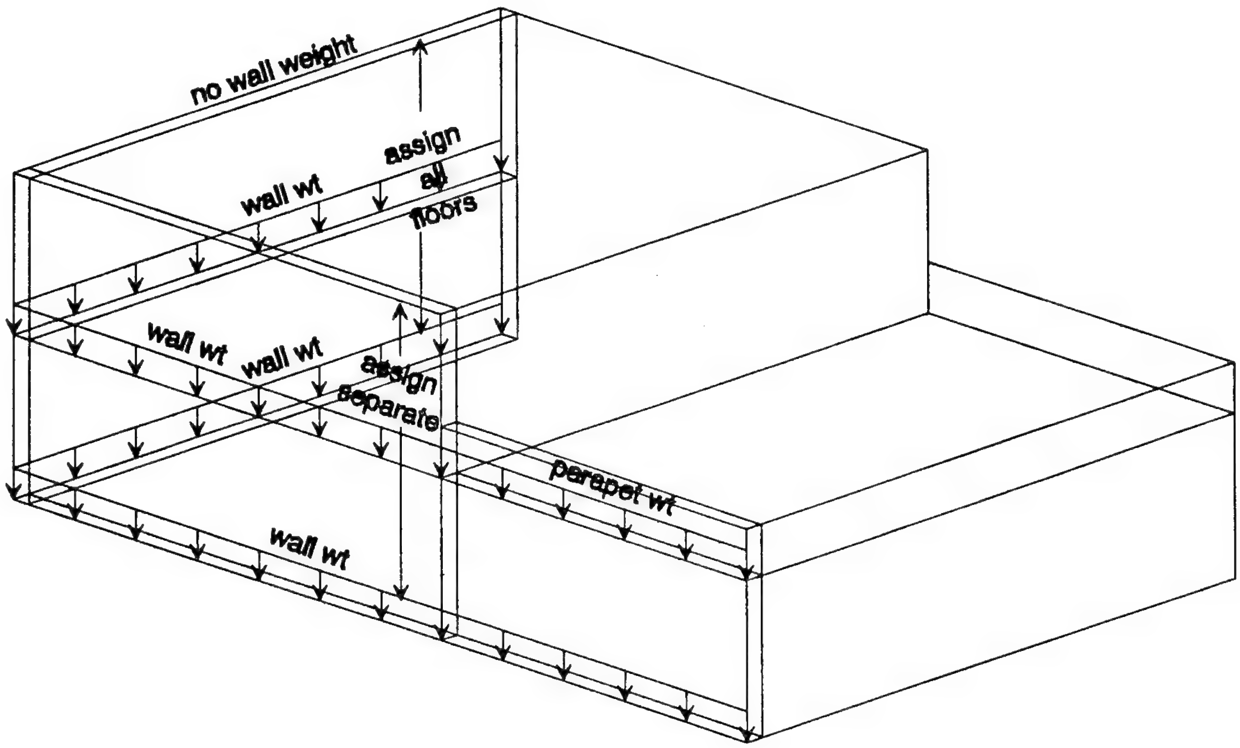
End

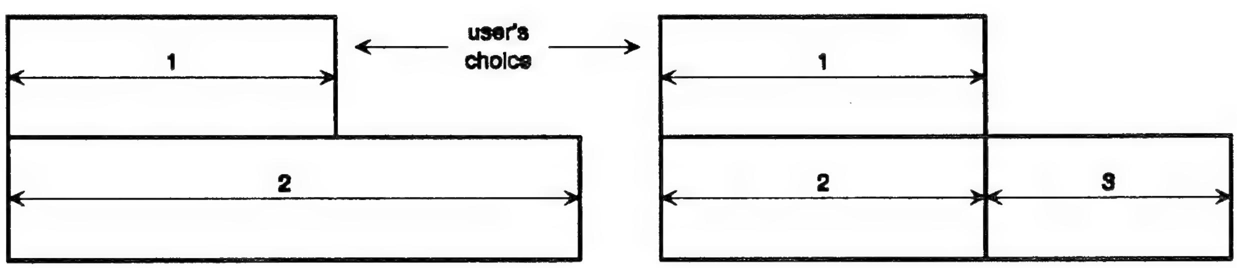

A
B
C
24'0"
24'0"
1
2
3
4
24'0"
24'0"
24'0"
Upper Roof


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Stairs
Second Floor/Lower Roof



Assign Wall Loads Philosophy





this appproach saves memory

Assign Loads

Start

Use Loads & Design Tool Palette

Assign Live Loads

Select Second Floor/ Lower Roof Horizontal Structural Plane

Use Occupancy (LL)

Highlight: Offices 50 psf

Assign Offices 50 psf

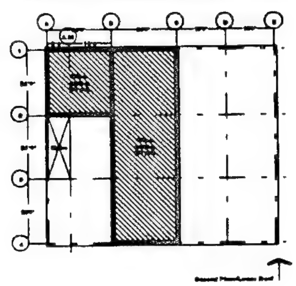
	Horizontal	Vertical
Base Point:	24'10"	10"
Point 2:	48'10"	72'10"
Length:	24'0"	72'0"

Snap To Grid

F2 Key For Keyboard Input

Assign Offices 50 psf

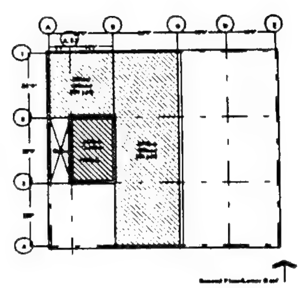
	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	24'10"	72'10"
Length:	24'0"	24'0"



Highlight: Corridor: Main 100 psf

Assign Corridor: Main 100 psf

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	24'10"	48'10"
Length:	16'0"	24'0"

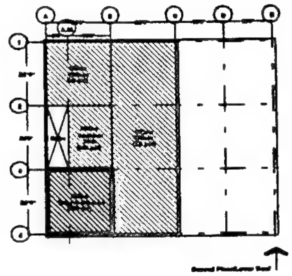


Highlight: Files & Storage 150 psf

Assign Live Loads

Assign Files & Storage 150 psf

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	24'10"	24'10"
Length:	24'0"	24'0"



Stop Using Occupancy (LL)

Assign Dead Loads → **Assign Floor Loads** → **Use Floor (DL)**

Assign Second Floor Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	24'10"
Length:	48'0"	24'0"

Assign Second Floor Load

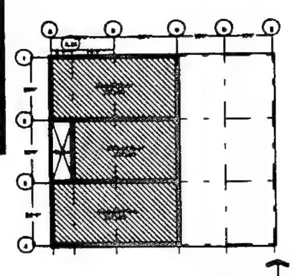
☐ Assign All Floors

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	48'10"	48'10"
Length:	40'0"	24'0"

Assign Second Floor Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	48'10"	72'10"
Length:	48'0"	24'0"



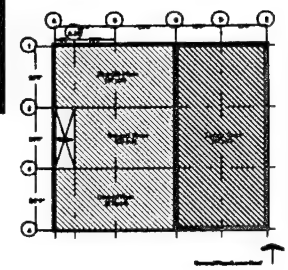
Stop Using Floor (DL)

Assign Dead Loads

Assign Roof Loads → **Use Roof (DL)**

Assign Lower Roof Load → Select Lower Roof

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	72'10"
Length:	36'0"	72'0"



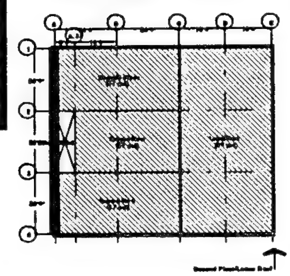
Stop Using Roof (DL)

Assign Exterior Wall Loads → **Use Wall (DL)**

Assign Exterior Wall Load → Select Exterior Wall

☒ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	10"	72'10"
Length:	0'0"	72'0"



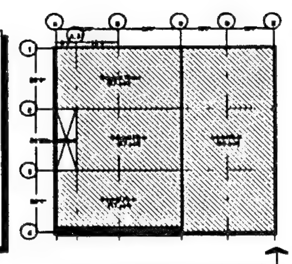
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	10"
Length:	48'0"	0'0"



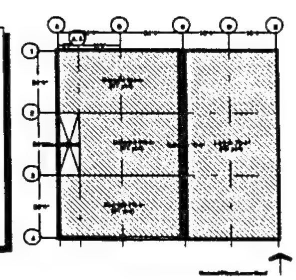
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	48'10"	72'10"
Length:	0'0"	72'0"



Assign Dead Loads

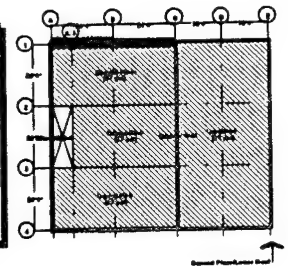
Assign Exterior Wall Loads

Wall Height
Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	72'10"
Point 2:	48'10"	72'10"
Length:	48'0"	0'0"



Wall Height
Start: 14'0"
End: 14'0"

Assign Parapet Wall Loads

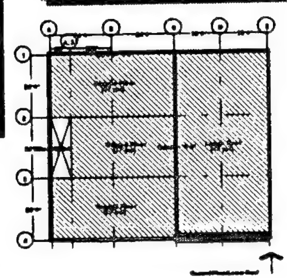
Use Wall (DL)

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	10"
Length:	36'0"	0'0"

Select Parapet Wall

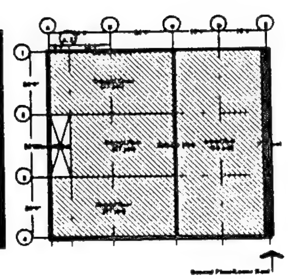


Wall Height
Start: 4'0"
End: 4'0"

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	10"
Point 2:	84'10"	72'10"
Length:	0'0"	72'0"



Wall Height
Start: 4'0"
End: 4'0"

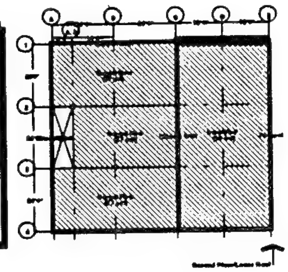
Assign Dead Loads

Assign Parapet Wall Loads

Assign Parapet Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	72'10"
Point 2:	84'10"	72'10"
Length:	36'0"	0'0"



Wall Height

Start: 4'0"
End: 4'0"

Stop Using Wall (DL)

Assign Upper Roof Loads

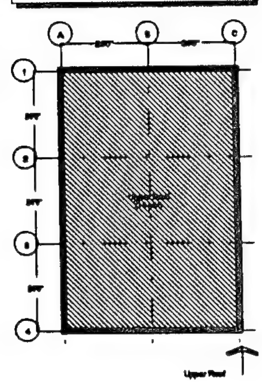
Select Upper Roof Horizontal Structural Plane

Use Roof (DL)

Assign Upper Roof Load

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	72'10"
Length:	48'0"	72'0"

Select Upper Roof



Stop Using Roof (DL)

Assign Ground Floor Wall Loads

Select Ground Floor Horizontal Structural Plane

Structural Plane Information

Name: Ground Floor

Assign Dead Loads

Assign Ground Floor Wall Loads

Close Structural Plane Information Dialog Window

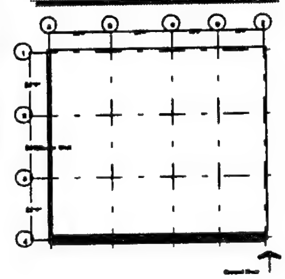
Use Wall (DL)

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	84'10"	10"
Length:	84'0"	0'0"

Select Exterior Wall



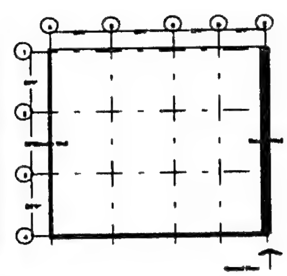
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	84'10"	10"
Point 2:	84'10"	72'10"
Length:	0'0"	72'0"



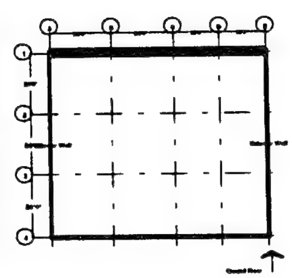
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

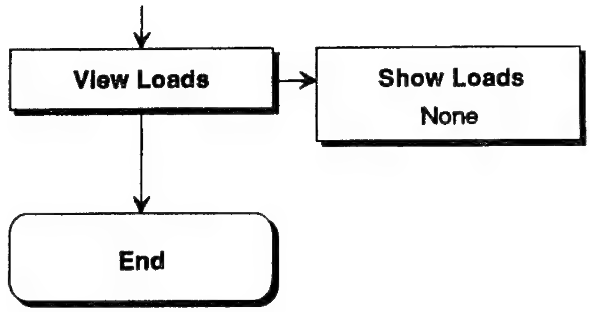
	Horizontal	Vertical
Base Point:	10"	72'10"
Point 2:	84'10"	72'10"
Length:	84'0"	0'0"

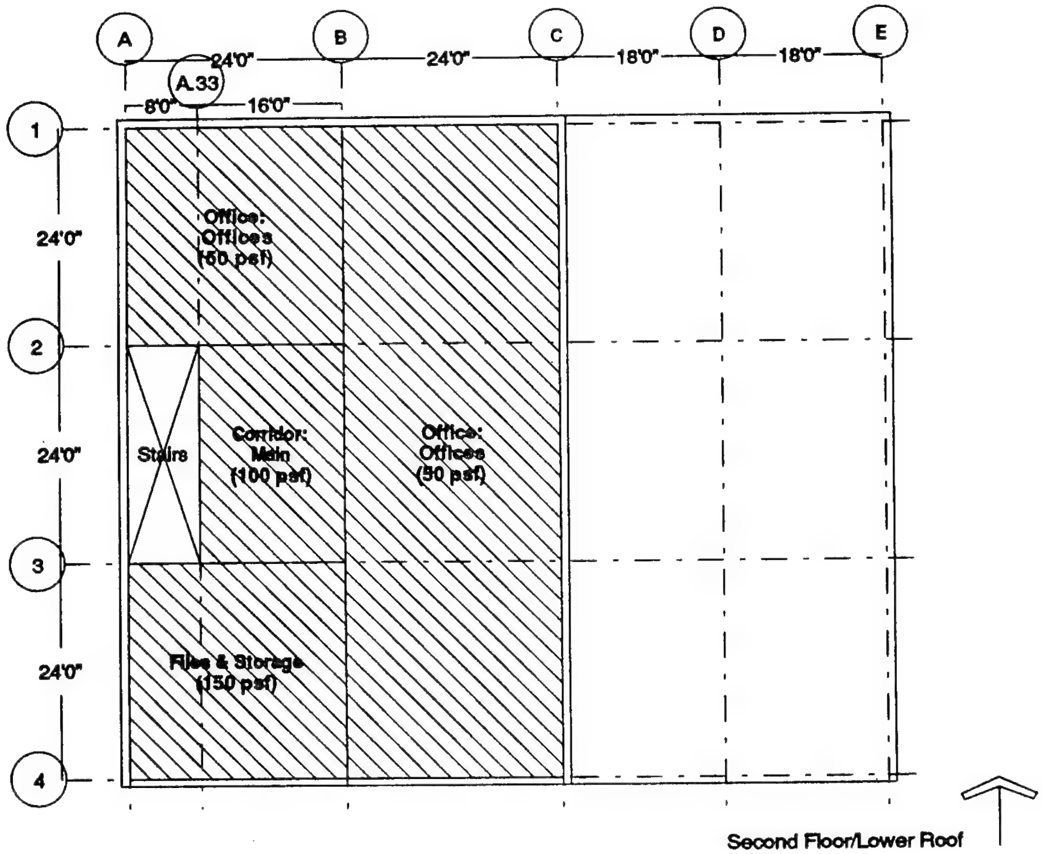


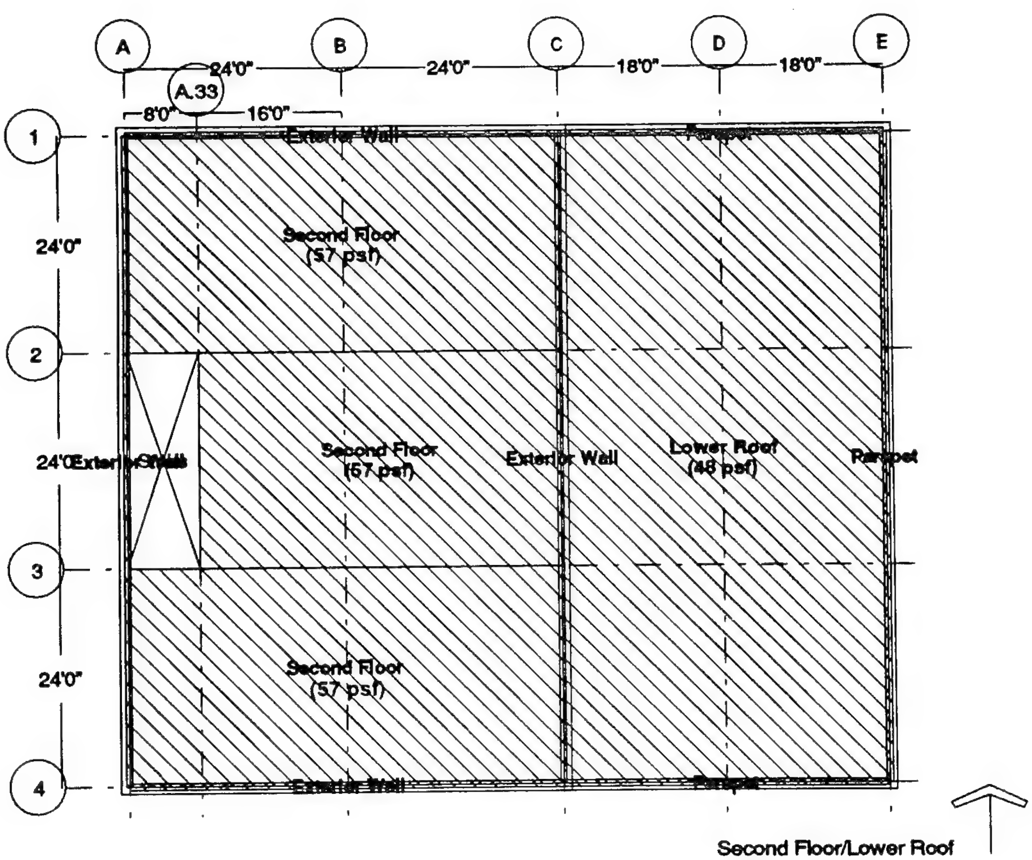
Wall Height

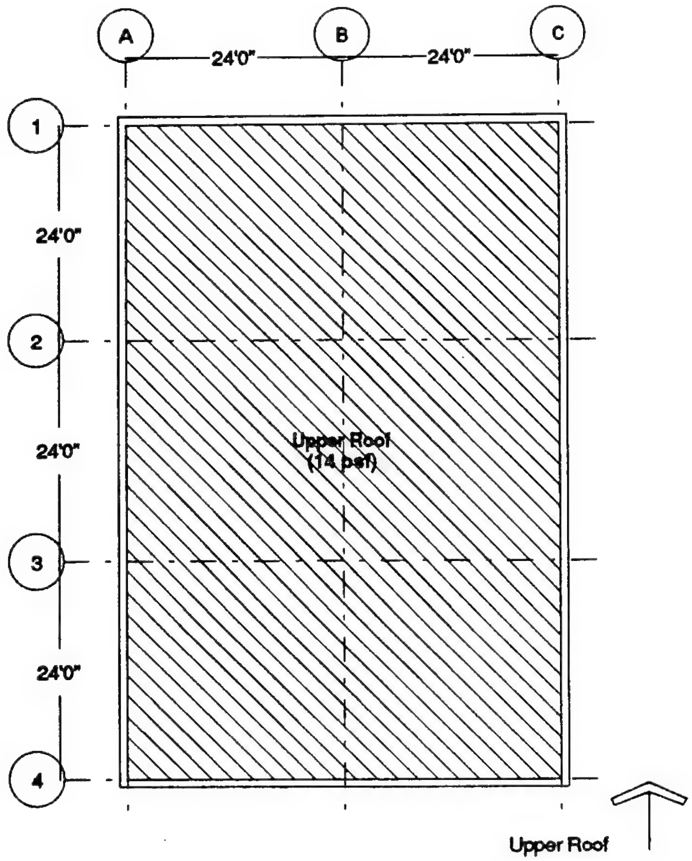
Start: 14'0"
End: 14'0"

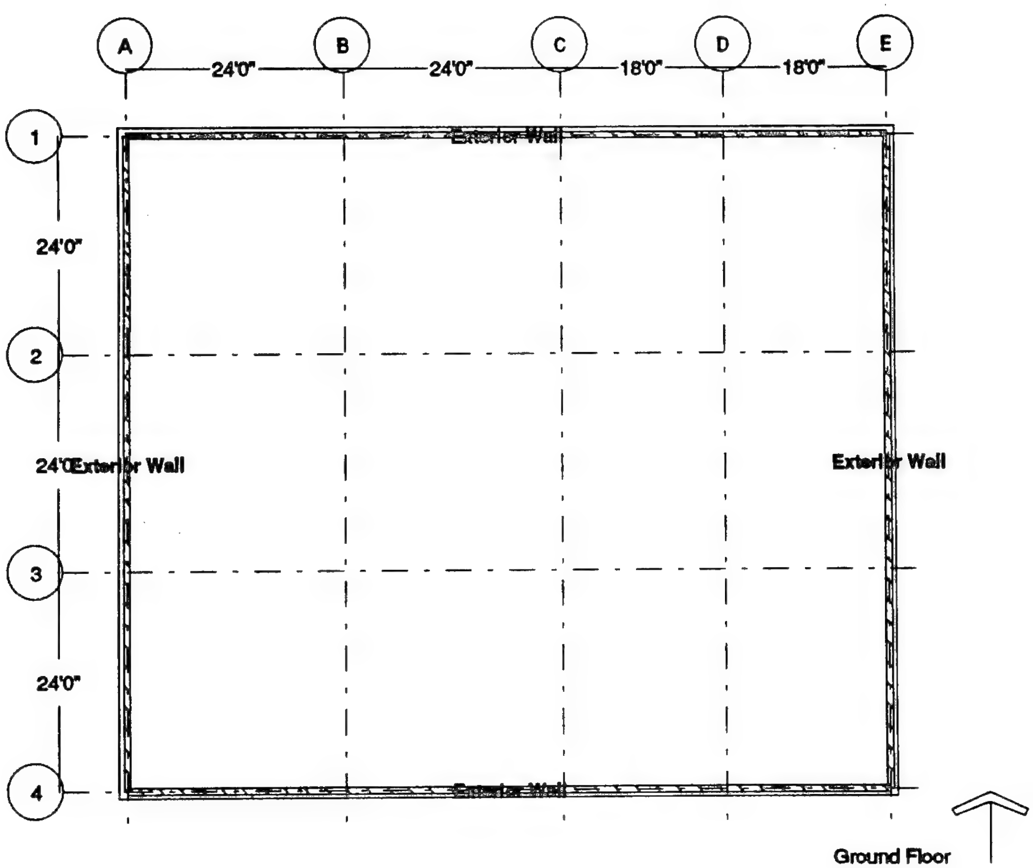
Stop Using Wall (DL)


View Loads
Show Loads
None
End


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Office:
Offices
(50 psf)
Stairs
Corridor:
Main
(100 psf)
Office:
Offices
(50 psf)
Files & Storage
(150 psf)
Second Floor/Lower Roof


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
A.33
8'0"
16'0"
1
2
3
4
24'0"
24'0"
24'0"
Exterior Wall
Second Floor
(57 psf)
Second Floor
(57 psf)
Exterior Wall
Lower Roof
(48 psf)
Parapet
Second Floor
(57 psf)
Exterior Wall
Second Floor/Lower Roof

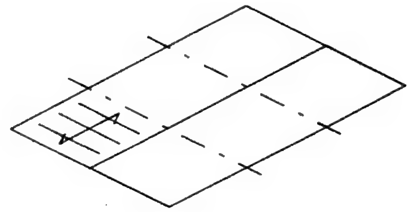

A
B
C
24'0"
24'0"
1
2
3
4
24'0"
24'0"
24'0"
Upper Roof
(14 psf)
Upper Roof


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
1
2
3
4
24'0"
24'0"
24'0"
Exterior Wall
Exterior Wall
Exterior Wall
Exterior Wall
Ground Floor

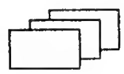
Analysis & Design Philosophy

Preliminary Analysis

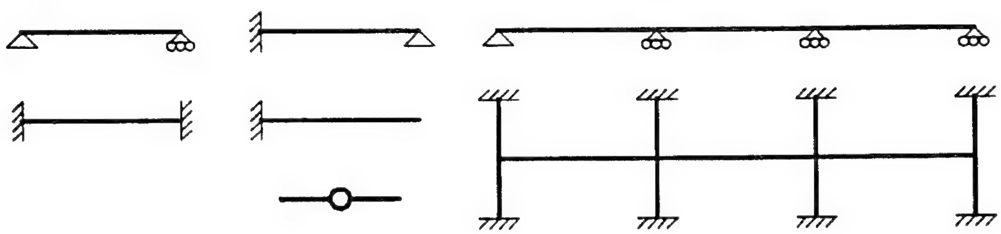
A. Select: * Material
* Load Combination
(Live Load Reduction)
* Element To Analyze



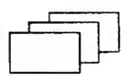
B. Review: * Attributes
* Guidelines



C. Connectivity

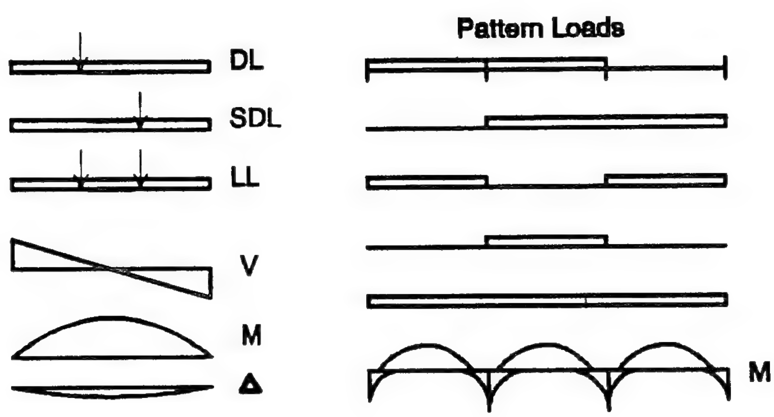


D. Self Weight Estimate * Guidelines



E. Analysis * Review Loads
* Connectivity

* Analysis Output
I = 1
E = 1
A = 1000

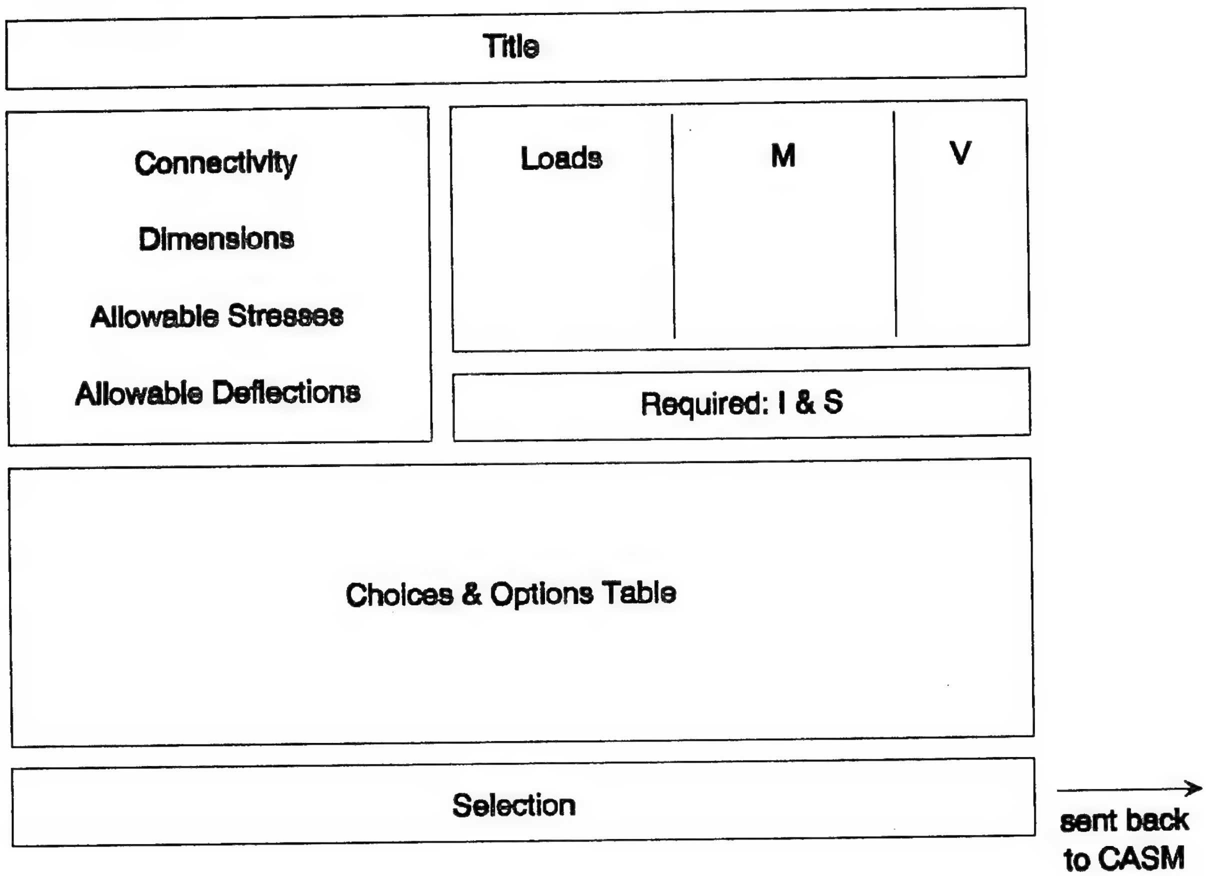


F. Re-Analysis (with real properties)

Preliminary Design

* Maximum V's, M's, R's, etc. sent to Excel

Spreadsheets



Surface Element Analysis

Start

Use Loads & Design Tool Palette

Select Upper Roof Horizontal Structural Plane

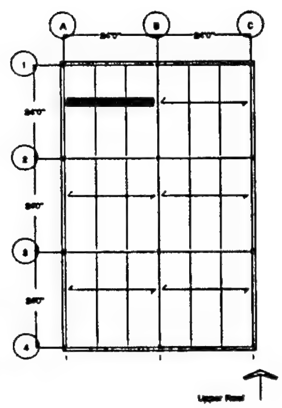
Material Steel

Select Element To Analyze & Design

Surface One-Way Roof Deck

Select A One-Way Surface Element

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

Use Compare Min. Roof LL & Snow Loads

Analysis

Units: Feet & Pounds

Decking Analysis

Number Of Spans:	3
Distance From Edge:	12'
Starting Span Number:	1

Snow Load Options

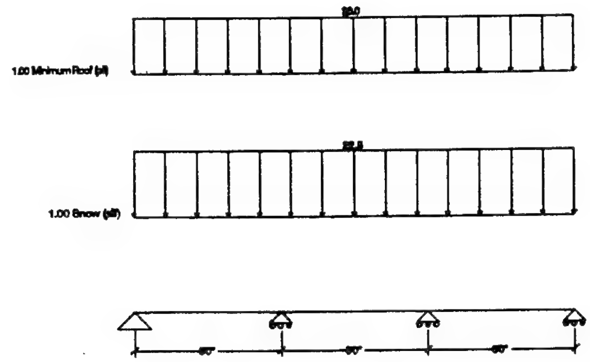
◉ Combined Snow Loads

Minimum Roof (LL)

Compare Min. Roof LL & Snow Loads

Compare Min. Roof LL & Snow Loads

View Shear, Moment & Deflection Diagrams



Load Combination D + S

Use Load Combination

Set Factors
Dead: 1.0
Snow: 1.0

Add

OK Button To Close Dialog Window

Highlight D+S In List

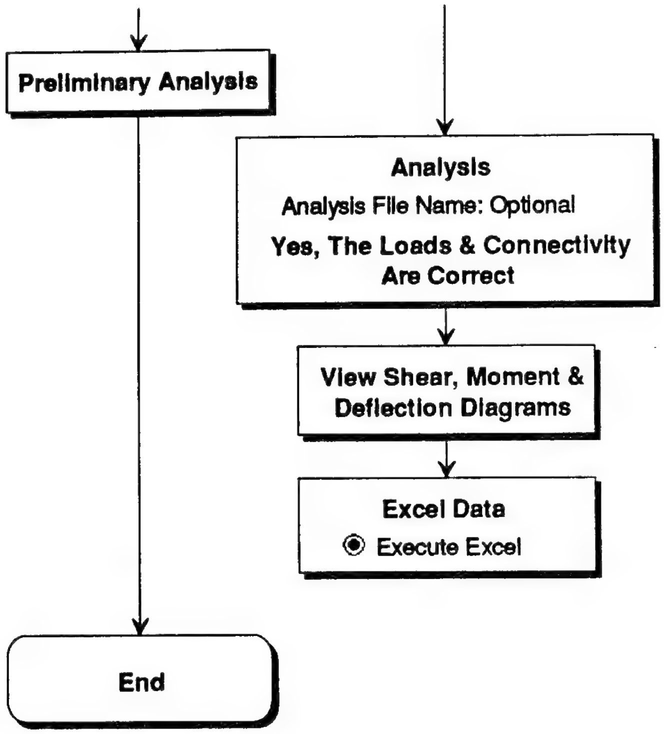
Preliminary Analysis

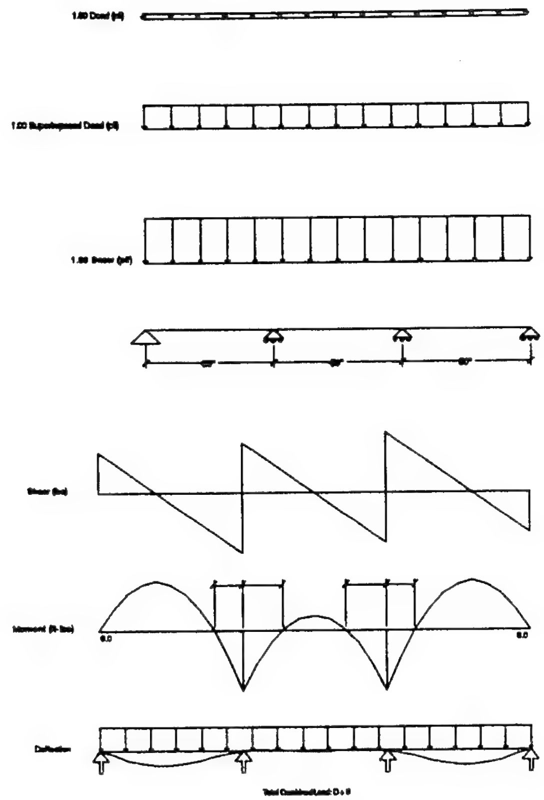
Use Preliminary

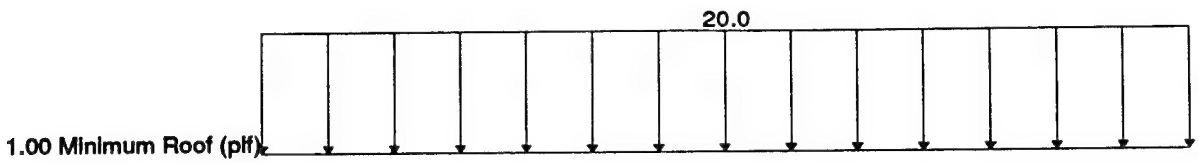
Analysis
Units: Feet & Pounds
Load Combination: D+S
☐ Use Actual Properties
☐ DL=Deck+Self Weight

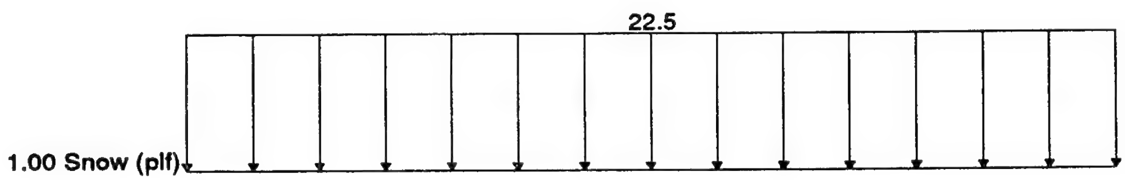
Decking Analysis
Number Of Spans: 3
Distance From Edge: 12'
Starting Span Number: 1
☒ Include Superimposed Dead Load

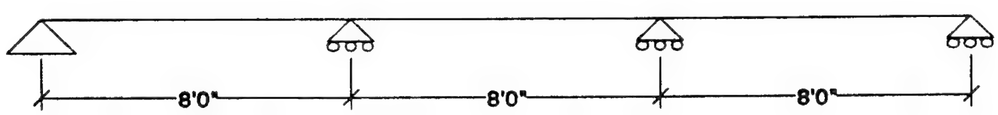
Snow Load Options
◉ Combined Snow Loads


Preliminary Analysis
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End

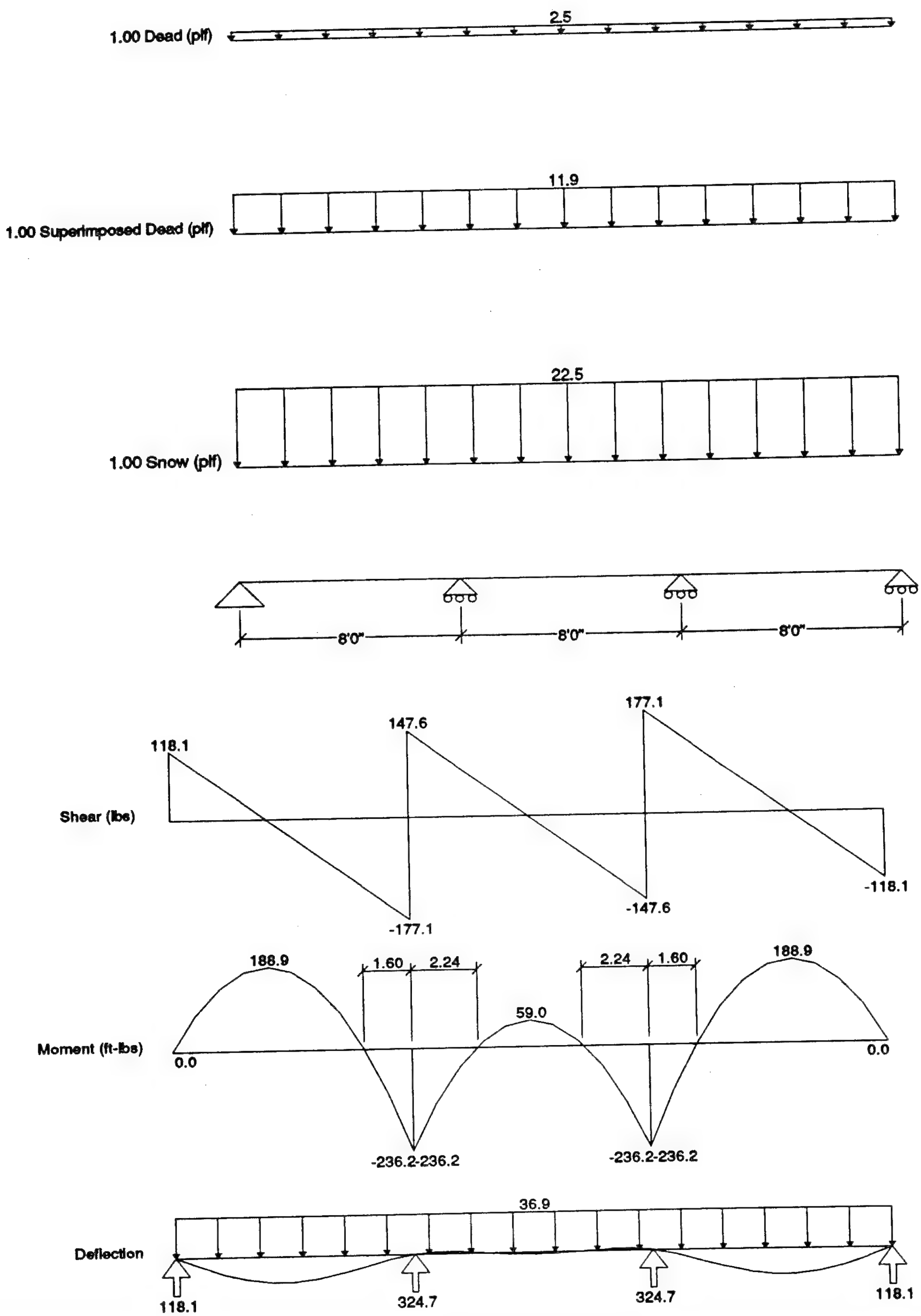






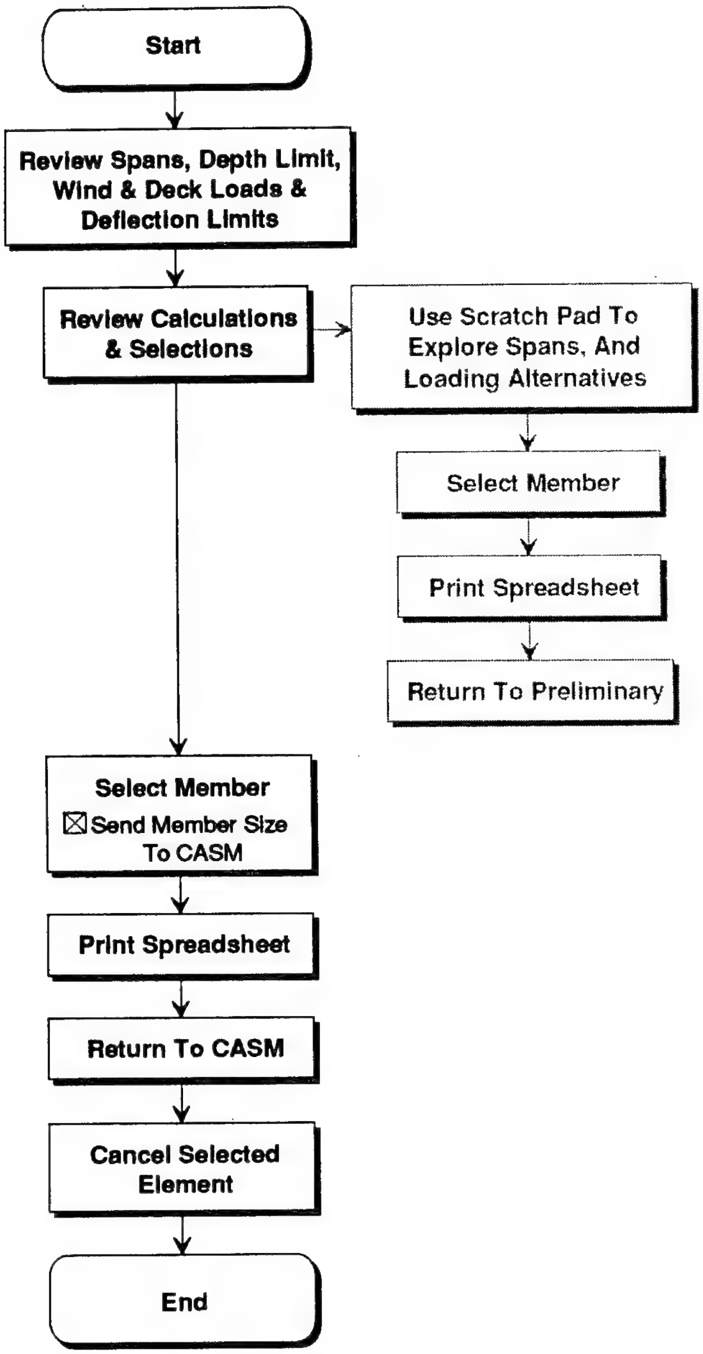



```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load : TM 5-809-1 1992
Time         : Tue Aug 30, 1994  12:08 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 24.0 sqft
Roof Slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 20.00 psf     |
+------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



Total Combined Load: D + S

Steel Roof Deck Design



STEEL ROOF DECK PRELIMINARY SELECTION

Project: Office Building - Scheme A	**Date:** Aug 30, 1994
Location: Radford AAP	**Engr:**

Load and Analysis Data:

Method: Analysis
Member ID:
Connectivity: Beam (Left)
Beam (Right)
Deck Span: 8 ft
Trib Width= 12 in
Depth Limit= **1.5** in. max
Fy= 33.0 ksi
Fb= 20.0 ksi
Fv= 13.2 ksi
E = 29,000 ksi
Live Ld Defl= **L/240** =0.40 in
Total Defl= **L/180** =0.53 in

Load Combination: D + S

Load Type	Factored Moments (lb-ft) Left	Mid	Right	Fact. Reactions Left(lb)	Right(lb)
Deck	16.0	12.8	16.0	12.0	12.0
Sup Dead	76.2	60.9	76.2	57.1	57.1
Live					
Lmin Roof					
Snow	144.0	115.2	144.0	108.0	108.0
Wind					
Summary	236.2	188.9	236.2	177.1	177.1

Load Combinations for roof:

Load Case #1:	D + S	Est. Deck Wgt = **2.0 psf**
Load Case #2:	Deck + Wind	Wind Load = **-30.0 psf**
Load Case #3:	Deck + Construction 200# Point Load	

Deck Configuration:

Deck Type: Roof Deck

Code Load Combinations:

	Case	Load (psf)	Fb Factor	M+ (f-lb)	M- (f-lb)	S+ (in.3)	S- (in.3)	Ix (in.4)
Number of spans = 3	# 1		1.00	188.9	92.2	0.113	0.055	0.1531
	# 2	-28.0	1.33	209.7	-168.4	0.095	-0.076	0.1263
	# 3	2.0	1.33	332.0	-183.0	0.150	-0.083	0.1716
Maximums:				332.0	-183.0	**0.150**	**-0.083**	**0.1716**

Steel Roof Deck Selection Table - Spans = 3

Deck Type	Gage	Depth (in)	Sx+ (in.^3)	Sx- (in.^3)	Ix (in.^4)	Dk wgt (psf)	Const Span Limit 1 Span	2+Span
WR 20	20	1.5	0.232	-0.245	0.210	2.1	6'-3"	7'-5"
IR18	18	1.5	0.189	-0.194	0.206	2.7	6'-2"	7'-4"
WR18	18	1.5	0.316	-0.325	0.290	2.8	7'-6"	8'-10"
NR18	18	1.5	0.163	-0.168	0.188	2.8	5'-11"	6'-11"

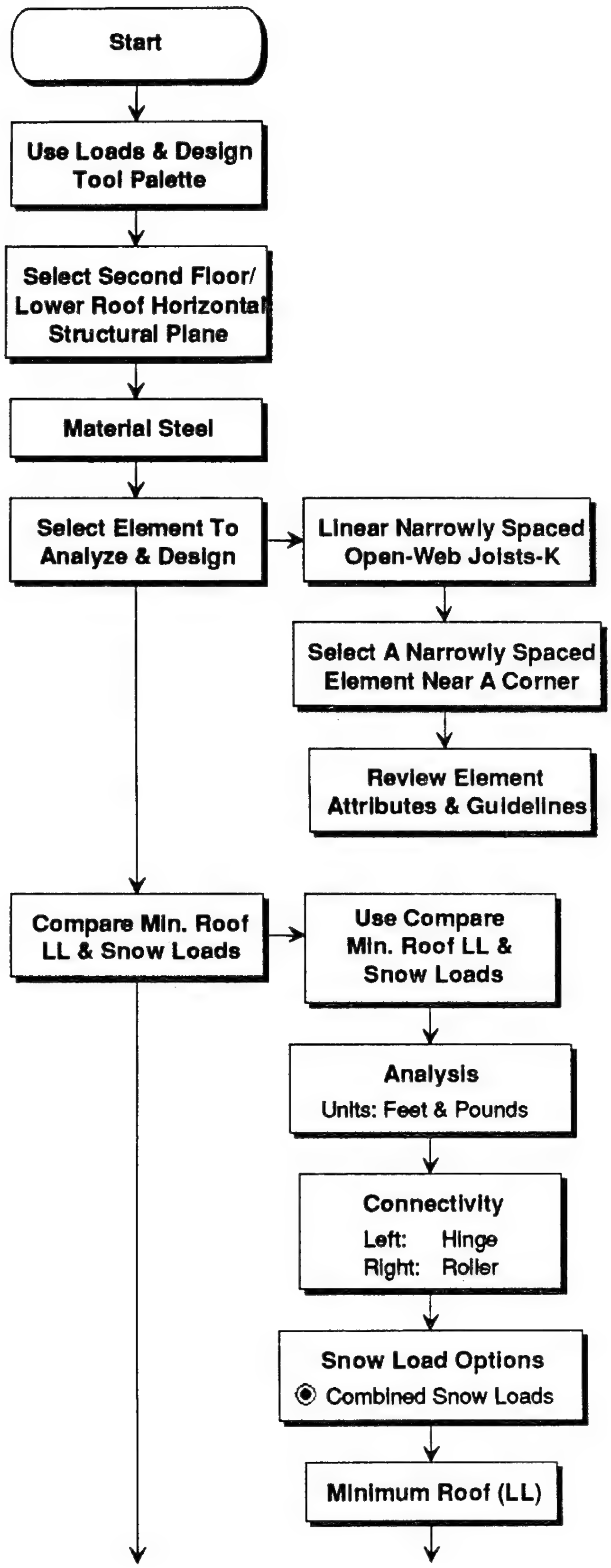
CASM Preliminary Steel Roof Deck Selection:

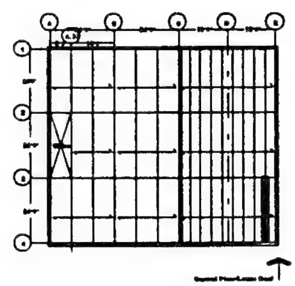
Deck Type: **WR 20**	Span= 8.0 ft	Depth: 1.5 in	Description: 2-1/2"Rib@6"oc	
Weight: 2.1 psf	Gage: 20	Ix = 0.21	Construction Load Span Limits:	
	Sx+ = 0.232	Sx- = -0.245	1 span: 6'-3"	2+span: 7'-5"

Notes:

1. Steel roof deck properties from representative manufacturer's data.
2. Design calculations from SDI Design Manual for Roof Deck - 1987.

Narrowly Spaced Element Analysis

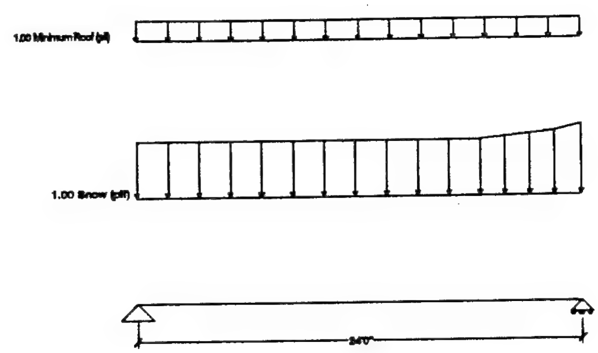




Compare Min. Roof LL & Snow Loads

Compare Min. Roof LL & Snow Loads

View Shear, Moment & Deflection Diagrams



Load Combination D + S

Use Load Combination

Set Factors
Dead: 1.0
Snow: 1.0

Add

OK Button To Close Dialog Window

Highlight D+S In List

Preliminary Analysis

Use Preliminary

Analysis
Units: Feet & Pounds
Load Combination: D+S
☐ Use Actual Properties
☐ DL=Deck+Self Weight

Connectivity
Left: Hinge
Right: Roller

Snow Load Options
◉ Combined Snow Loads

Preliminary Analysis

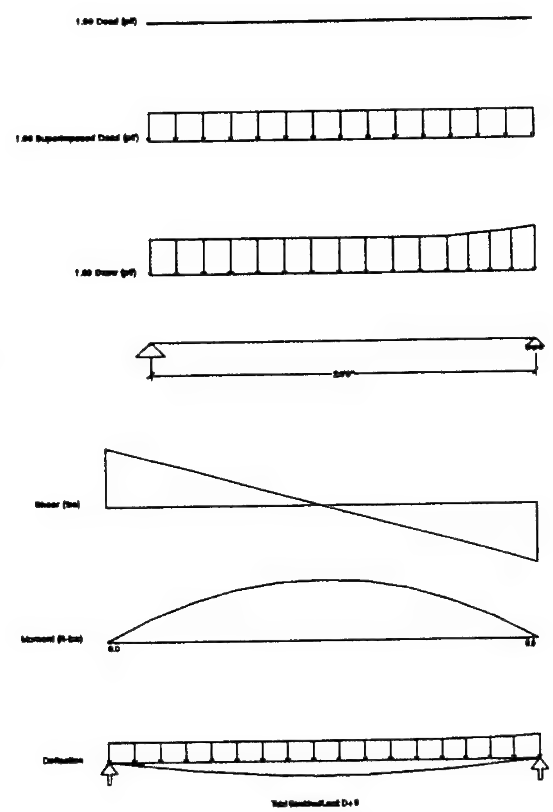
Self Weight
Estimated Self Weight: 0.0

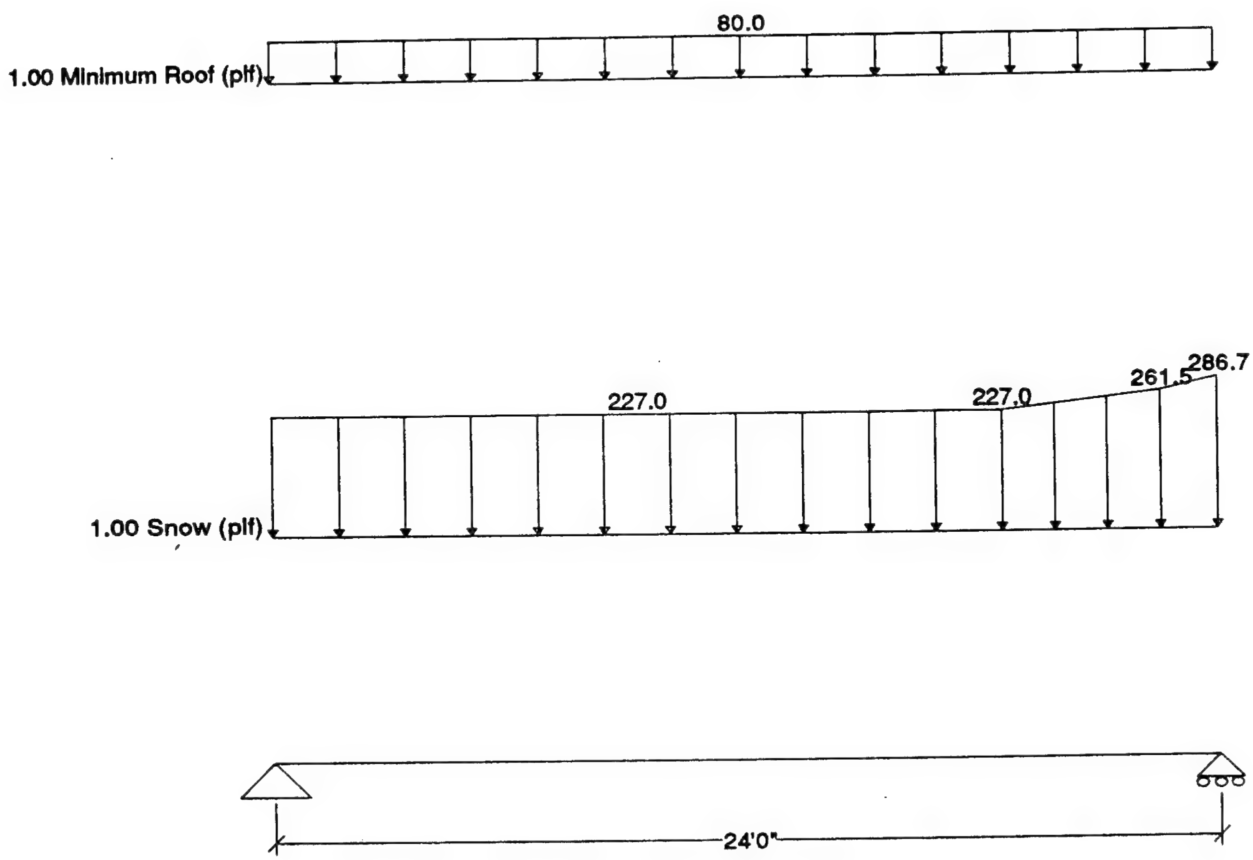
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct

View Shear, Moment & Deflection Diagrams

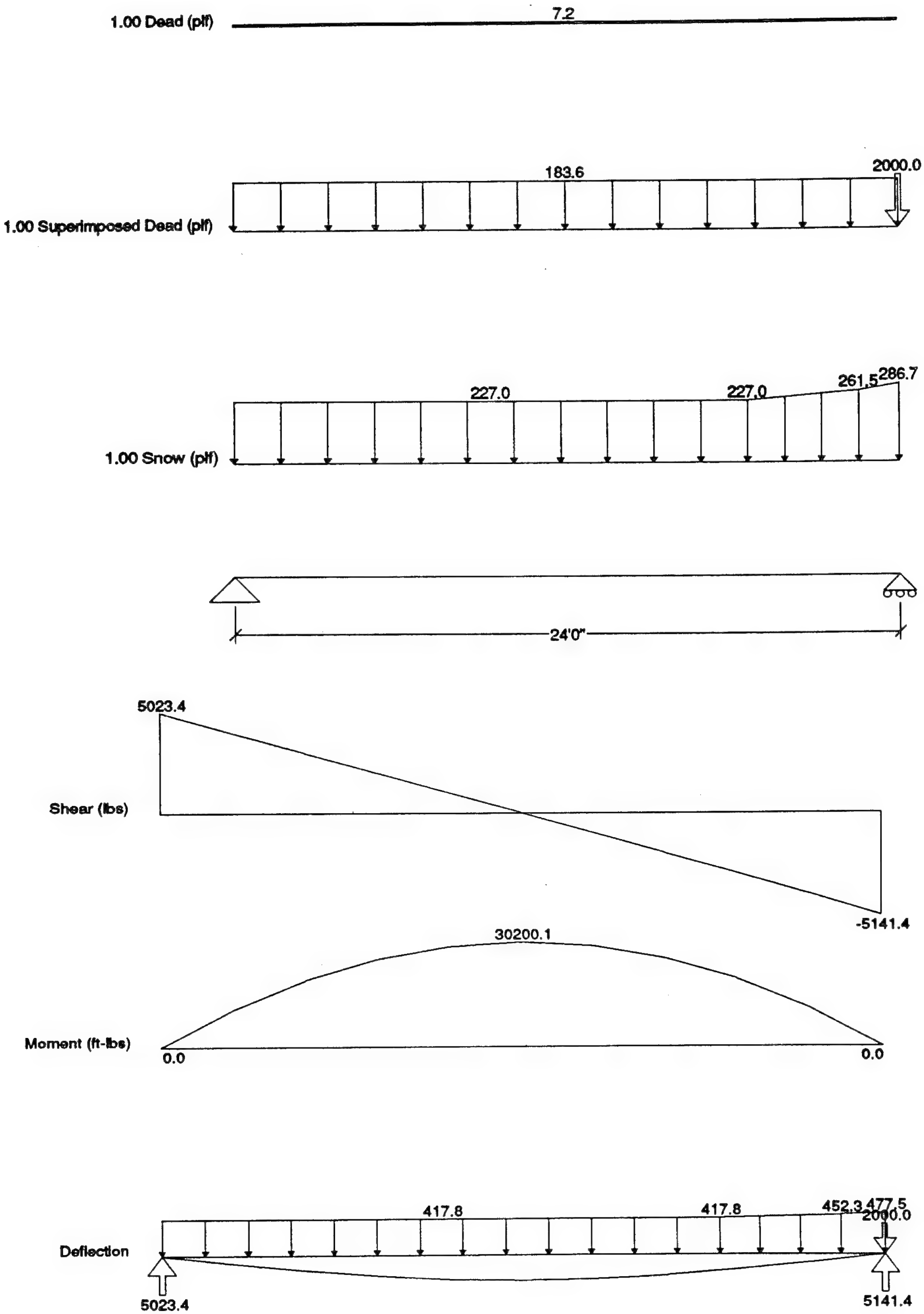
Excel Data
◉ Execute Excel

End






```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Tue Aug 30, 1994  2:44 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At)  : 96.0 sqft
Roof Slope     (F)   : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 20.00 psf      |
+-------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.
```



Total Combined Load: D + S

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

********************************** I N P U T **********************************

Office Building - Scheme A — 1.00 Dead Load

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	1

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-7.20	0.00		2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	8.640	3.456	0.000	8.640	-3.456

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL EIJ	STIFF EJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

******************************** O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-597.1968
2	0.0000	-16872.4818	-563.7538
3	0.0000	-31921.8411	-472.9799
4	0.0000	-43703.3396	-339.2078
5	0.0000	-51185.0211	-176.7703
6	0.0000	-53747.7120	0.0000
7	0.0000	-51185.0211	176.7703
8	0.0000	-43703.3396	339.2078
9	0.0000	-31921.8411	472.9799
10	0.0000	-16872.4818	563.7538
11	0.0000	0.0000	597.1968

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	86.400	0.000	0.000	-69.120	186.624
2	0.000	69.120	-186.624	0.000	-51.840	331.776
3	0.000	51.840	-331.776	0.000	-34.560	435.456
4	0.000	34.560	-435.456	0.000	-17.280	497.664
5	0.000	17.280	-497.664	0.000	0.000	518.400
6	0.000	0.000	-518.400	0.000	17.280	497.664
7	0.000	-17.280	-497.664	0.000	34.560	435.456
8	0.000	-34.560	-435.456	0.000	51.840	331.776
9	0.000	-51.840	-331.776	0.000	69.120	186.624
10	0.000	-69.120	-186.624	0.000	86.400	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	86.400	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	86.400	0.000

PROBLEMS COMPLETED

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

********************************** I N P U T **********************************

Office Building - Scheme A -- 1.00 Superimposed Dead Load

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	1

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-183.60	0.00		2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	220.320	88.128	0.000	220.320	-88.128

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

******************************* O U T P U T *******************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-15228.5184
2	0.0000	-430248.2847	-14375.7214
3	0.0000	-814006.9483	-12060.9866
4	0.0000	-1114435.1593	-8649.7985
5	0.0000	-1305218.0378	-4507.6414
6	0.0000	-1370566.6560	0.0000
7	0.0000	-1305218.0378	4507.6414
8	0.0000	-1114435.1593	8649.7985
9	0.0000	-814006.9483	12060.9866
10	0.0000	-430248.2847	14375.7214
11	0.0000	0.0000	15228.5184

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	2203.200	0.000	0.000	-1762.560	4758.912
2	0.000	1762.560	-4758.912	0.000	-1321.920	8460.288
3	0.000	1321.920	-8460.288	0.000	-881.280	11104.128
4	0.000	881.280	-11104.128	0.000	-440.640	12690.432
5	0.000	440.640	-12690.432	0.000	0.000	13219.200
6	0.000	0.000	-13219.200	0.000	440.640	12690.432
7	0.000	-440.640	-12690.432	0.000	881.280	11104.128
8	0.000	-881.280	-11104.128	0.000	1321.920	8460.288
9	0.000	-1321.920	-8460.288	0.000	1762.560	4758.912
10	0.000	-1762.560	-4758.912	0.000	2203.200	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	2203.200	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	2203.200	0.000

PROBLEMS COMPLETED

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

******************************** I N P U T ********************************

Office Building - Scheme A -- 1.00 Snow Load

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	4

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-226.99	0.00		2.40
2	UNIFRM	2.40	-226.99	0.00		1.74
2	RAMP	2.40	-226.99	1.74	-232.69	2.40
3	RAMP	2.40	-232.69	0.00	-253.40	2.40
4	RAMP	2.40	-253.40	0.00	-261.49	0.94
4	RAMP	2.40	-261.49	0.94	-286.72	2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	272.386	108.954	0.000	272.386	-108.954
2	0.000	272.450	109.002	0.000	274.208	-109.265
3	0.000	286.687	115.669	0.000	296.627	-117.657
4	0.000	312.831	126.477	0.000	329.404	-129.853

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	2	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

******************************** O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-18962.7216
2	0.0000	-535784.4750	-17904.2668
3	0.0000	-1013855.3129	-15030.1394
4	0.0000	-1388427.8640	-10792.1951
5	0.0000	-1626730.9187	-5642.2892
6	0.0000	-1709006.7080	-32.2776
7	0.0000	-1628510.9034	5565.9844
8	0.0000	-1391512.6167	10760.6411
9	0.0000	-1017294.4159	15039.8270
10	0.0000	-538185.6478	17967.1701
11	0.0000	0.0000	19058.1368

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	2733.806	0.000	0.000	-2189.034	5907.408
2	0.000	2189.034	-5907.408	0.000	-1644.262	10507.364
3	0.000	1644.262	-10507.364	0.000	-1099.491	13799.868
4	0.000	1099.491	-13799.868	0.000	-554.719	15784.919
5	0.000	554.719	-15784.919	0.000	-9.947	16462.518
6	0.000	9.947	-16462.518	0.000	534.825	15832.664
7	0.000	-534.825	-15832.664	0.000	1079.597	13895.357
8	0.000	-1079.597	-13895.357	0.000	1626.255	10650.183
9	0.000	-1626.255	-10650.183	0.000	2209.569	6057.134
10	0.000	-2209.569	-6057.134	0.000	2851.803	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	2733.806	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	2851.803	0.000

PROBLEMS COMPLETED

****
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Tue Aug 30, 1994 4:20 PM

******************************** I N P U T ********************************

Office Building - Scheme A — Total Combined Load: D + S

NUMBER OF ELEMENTS = 10
NUMBER OF NODAL POINTS = 11
NUMBER OF MATERIALS = 1
NUMBER OF ELEMENT TYPES = 1
NUMBER OF ELASTIC SUPPORT TYPES = 0
NUMBER OF FIXED END FORCE TYPES = 4

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	2.40	-417.79	0.00		2.40
2	UNIFRM	2.40	-190.80	0.00		2.40
2	UNIFRM	2.40	-226.99	0.00		1.74
2	RAMP	2.40	-226.99	1.74	-232.69	2.40
3	UNIFRM	2.40	-190.80	0.00		2.40
3	RAMP	2.40	-232.69	0.00	-253.40	2.40
4	UNIFRM	2.40	-190.80	0.00		2.40
4	RAMP	2.40	-253.40	0.00	-261.49	0.94
4	RAMP	2.40	-261.49	0.94	-286.72	2.40

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	501.346	200.538	0.000	501.346	-200.538
2	0.000	501.410	200.586	0.000	503.168	-200.849
3	0.000	515.647	207.253	0.000	525.587	-209.241
4	0.000	541.791	218.061	0.000	558.364	-221.437

JOINT DATA

UNITS: FEET, POUNDS

				BOUNDARY CONDITIONS			
		NODAL COORDINATES		NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	2	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

******************************** O U T P U T ********************************

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-34788.4368
2	0.0000	-982905.2414	-32843.7420
3	0.0000	-1859784.1024	-27564.1059
4	0.0000	-2546566.3629	-19781.2013
5	0.0000	-2983133.9776	-10326.7009
6	0.0000	-3133321.0760	-32.2776
7	0.0000	-2984913.9624	10270.3961
8	0.0000	-2549651.1156	19749.6473
9	0.0000	-1863223.2053	27573.7935
10	0.0000	-985306.4142	32906.6452
11	0.0000	0.0000	34863.8520

MEMBER END FORCES

UNITS: FEET, POUNDS

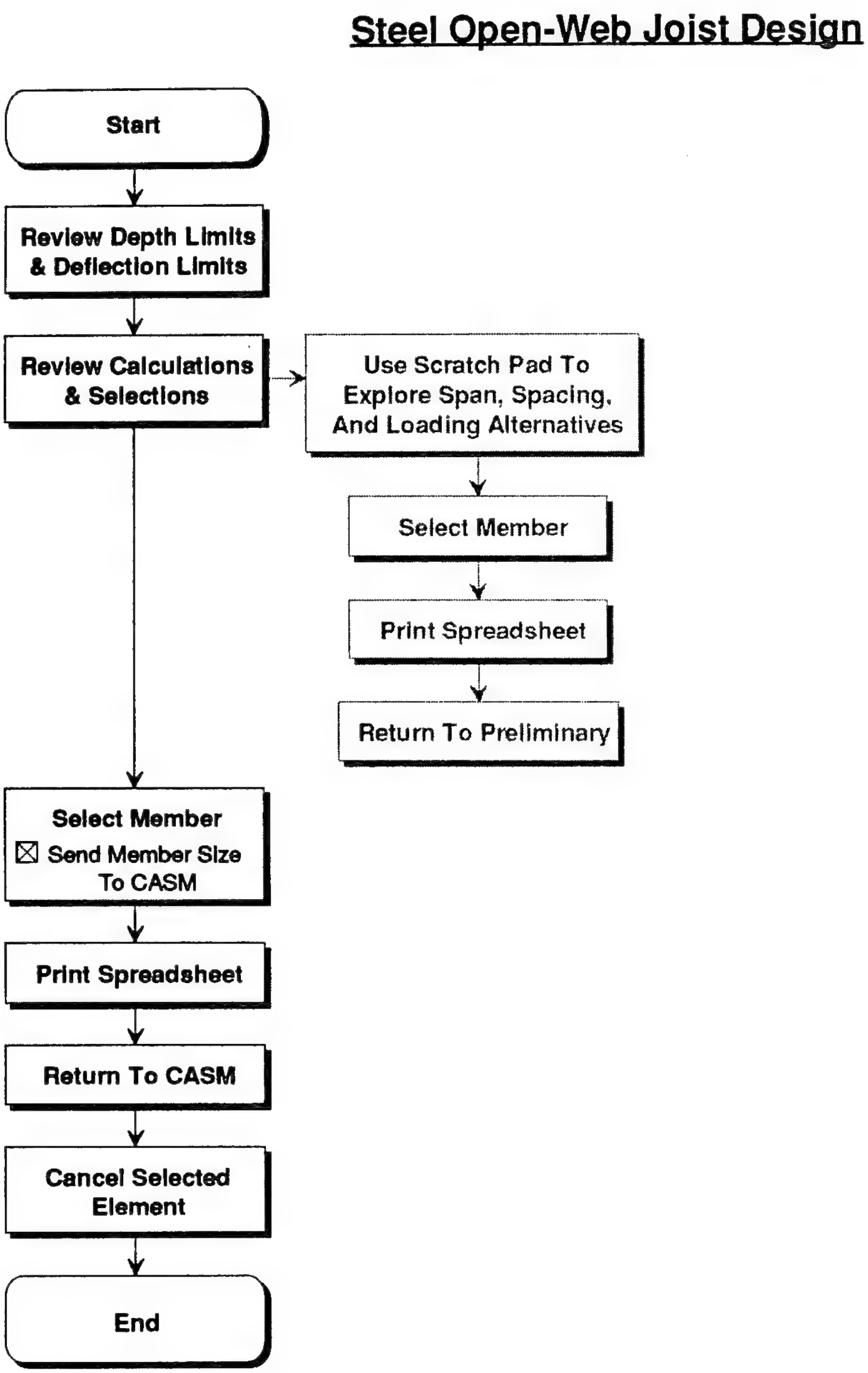
ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	5023.406	0.000	0.000	-4020.714	10852.944
2	0.000	4020.714	-10852.944	0.000	-3018.022	19299.428
3	0.000	3018.022	-19299.428	0.000	-2015.331	25339.452
4	0.000	2015.331	-25339.452	0.000	-1012.639	28973.015
5	0.000	1012.639	-28973.015	0.000	-9.947	30200.118
6	0.000	9.947	-30200.118	0.000	992.745	29020.760
7	0.000	-992.745	-29020.760	0.000	1995.437	25434.941
8	0.000	-1995.437	-25434.941	0.000	3000.015	19442.247
9	0.000	-3000.015	-19442.247	0.000	4041.249	11002.670
10	0.000	-4041.249	-11002.670	0.000	5141.403	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	5023.406	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	5141.403	0.000

PROBLEMS COMPLETED


Steel Open-Web Joist Design
Start
Review Depth Limits & Deflection Limits
Review Calculations & Selections
Use Scratch Pad To Explore Span, Spacing, And Loading Alternatives
Select Member
Print Spreadsheet
Return To Preliminary
Select Member
☒ Send Member Size To CASM
Print Spreadsheet
Return To CASM
Cancel Selected Element
End

STEEL BAR JOIST PRELIMINARY SELECTION

Project: Office Building - Scheme A	**Date:** Aug 31, 1994
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

		Load Combination D + S	Factored Moment (ft-lb)			Factored Reaction	
Method:	Analysis	LoadType	Left	Mid	Right	Left(lb)	Right(lb)
Member ID:		Dead		518		86	86
Connection:	Hinge (Left) Roller (Right)	Sup Dead		13,219		2,203	2,203
Span:	24.0 ft	Live					
Spacing:	48.0 in	Lmin Roof					
Depth Limit=	**30.0** in. max	Snow		16,463		2,734	2,852
Fy=	50.0 ksi	Wind					
Fb=	30.0 ksi	Summary		30,200		5,023	5,141
E =	29,000 ksi						
Live Defl=	**L/360=** 0.80 in	Moment	Total Ld= 419 plf		Reaction	Total Ld= 428 plf	
Total Defl=	**L/240=** 1.20 in	EUL:	Live Ld= 229 plf		EUL:	Live Ld= 238 plf	
Ponding Check:	NO						

CASM Joist Selection Table: (joist capacities)

Joist Size	Spacing (in)	Total Ld(plf)	Live Ld(plf)	Mmax (ftlb)	Rmax (lb)	Live Ld Defl(in)	Total Ld Defl(in)	Ponding	Jst Wgt (plf)
20K4	48.0	430	353	30,960	5,160	0.54	0.98		7.6
18K5	48.0	434	318	31,248	5,208	0.61	1.10		7.7
22K4	48.0	475	431	34,200	5,700	0.45	0.81		8.0
20K5	48.0	485	396	34,920	5,820	0.49	0.88		8.2

CASM Bar Joist Selection:

Joist Size:	**20K4**	Span:	24.0 ft	Spacing:	48 in	TL defl:	0.98 in	LL defl:	0.54 in
Wgt(tons):	0.09	Mmax:	30,960	Rmax:	5,160	Total Ld:	430 plf	Live Ld:	353 plf

NOTES:

1. Bar joist selections based on 1993 SJI Load Tables.
   Edit spreadsheet stajstk.xls to revise selection table.
2. Approximate moment of inertia of the joist in inches^4 is:
   Ij = 26.767 (WLL) (L^3) (10^-6), where WLL = Live Load value in table;
   where L = Span - 0.33 in feet
3. Ponding check based on SJI Technical Digest. Refer to AISC Commentary section K2 for charts for Stress Constant U and Flexibility Constant C for joists bearing on beams.
   a. For joists bearing on steel beams, Cs must be greater than Csreq. This is not an automatic selection. Beam size and/or joist size may need to be increased.
   b. For joists bearing on walls, the ponding load includes dead load plus percentage of live load, plus computed ponding load. Selection is based on greatest load.

Widely Spaced Element Analysis: Beam

Start

↓

Use Loads & Design Tool Palette

↓

Select Second Floor/ Lower Roof Horizontal Structural Plane

↓

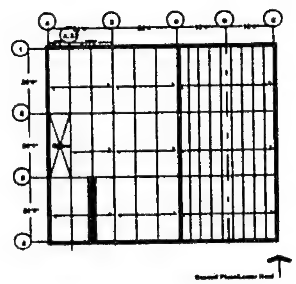
Material Steel

↓

Select Element To Analyze & Design → Linear Widely Spaced Rolled Section

↓ Select A Widely Spaced Element In Bay A3-B4

↓ Review Element Attributes & Guidelines



↓

Load Combination D + L → Use Load Combination

↓ Set Factors

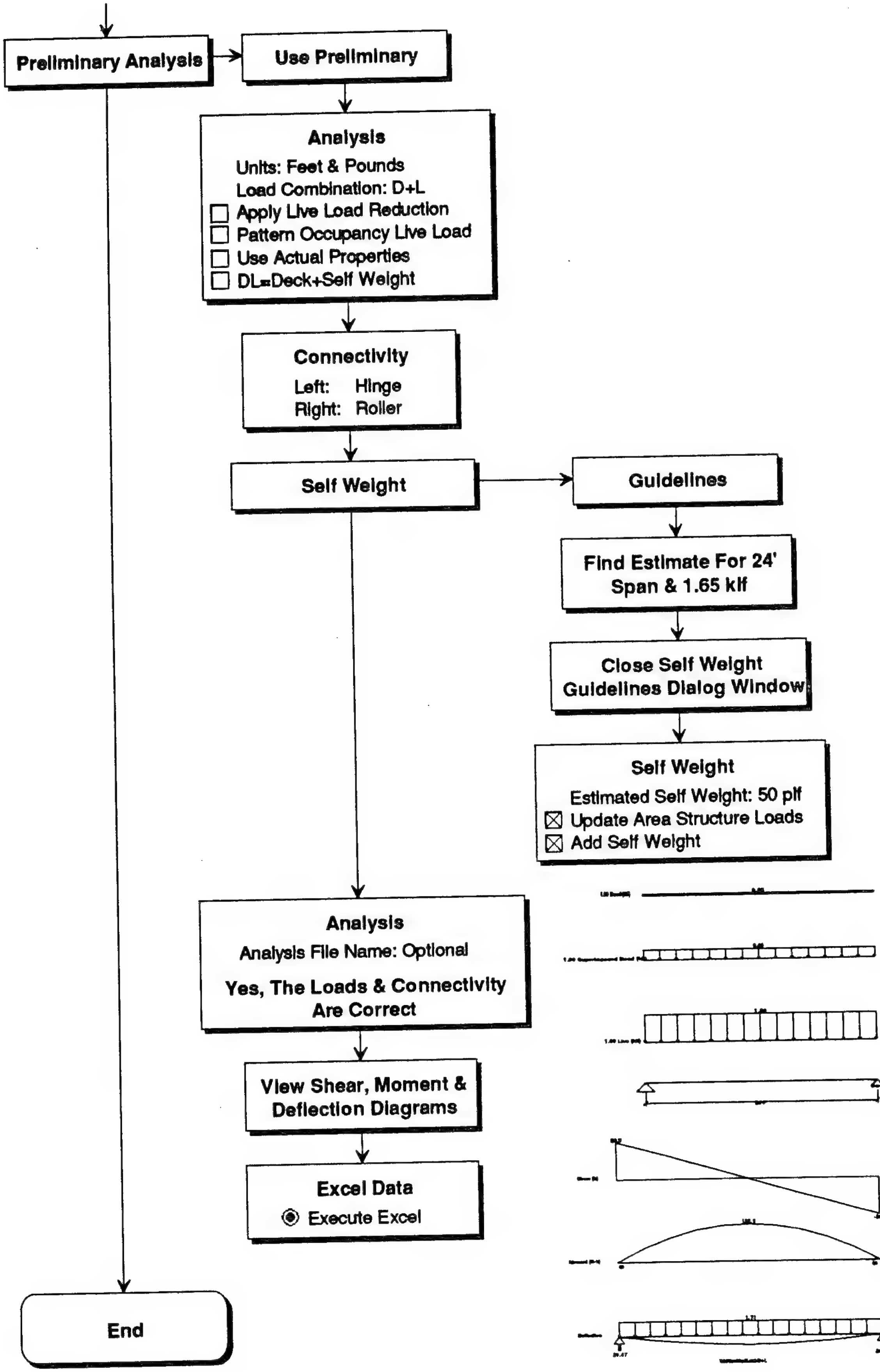
Dead: 1.0
Live: 1.0

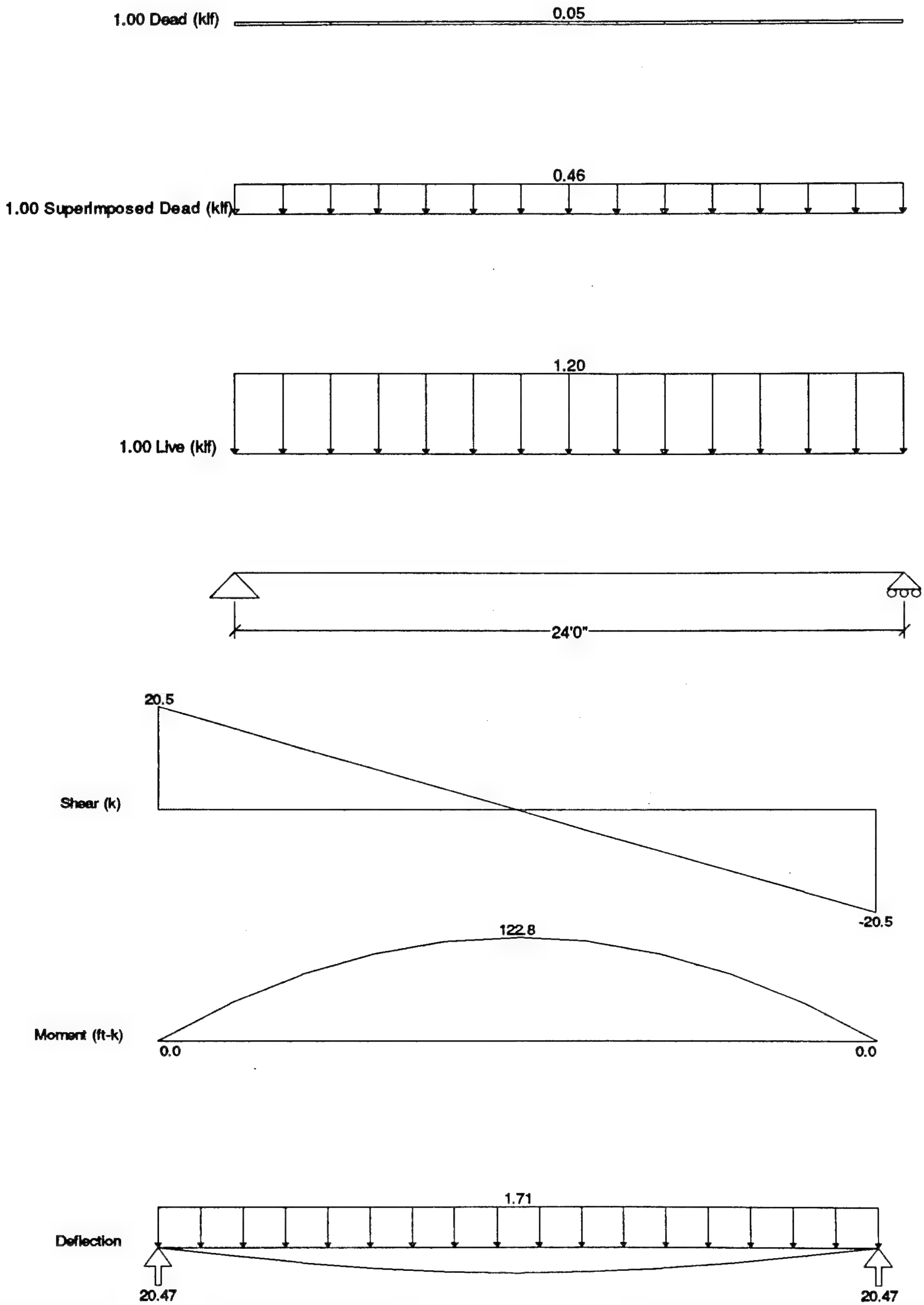
↓ Add

↓ OK Button To Close Dialog Window

→ Highlight D+L In List

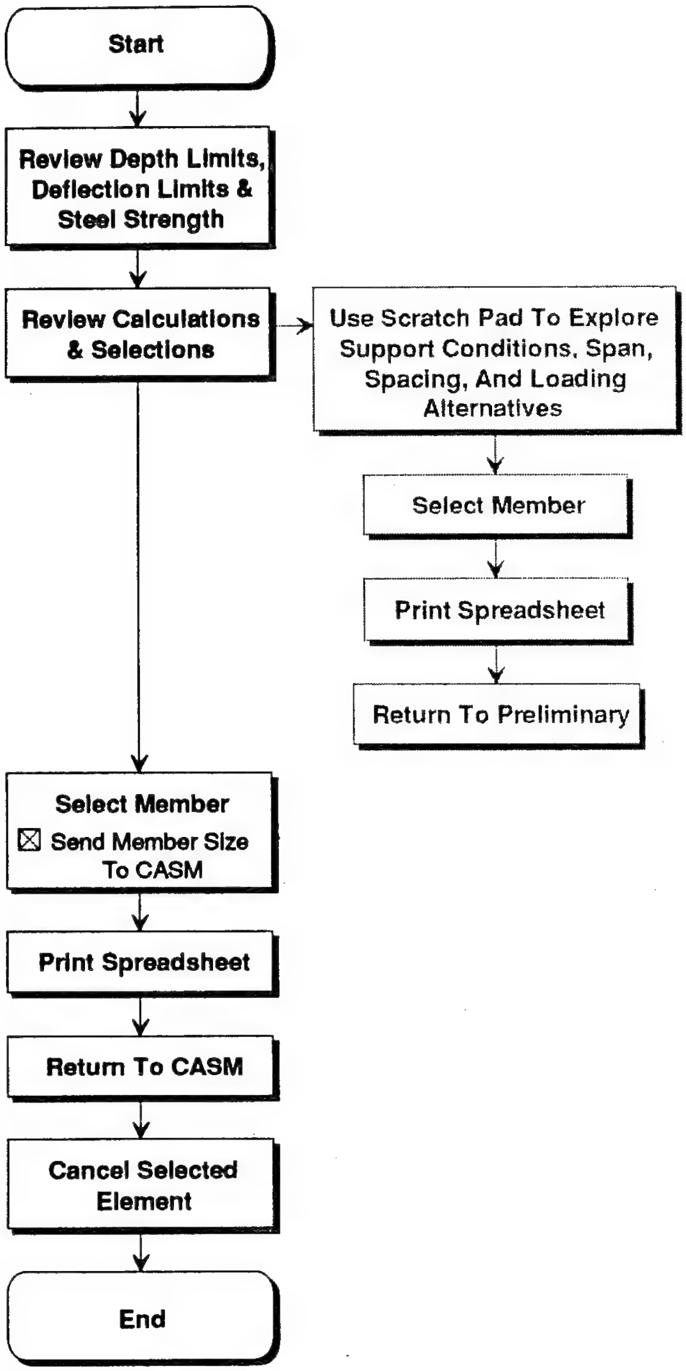
↓


Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+L
☐ Apply Live Load Reduction
☐ Pattern Occupancy Live Load
☐ Use Actual Properties
☐ DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Self Weight
Guidelines
Find Estimate For 24' Span & 1.65 klf
Close Self Weight Guidelines Dialog Window
Self Weight
Estimated Self Weight: 50 plf
☒ Update Area Structure Loads
☒ Add Self Weight
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
◉ Execute Excel
End



Total Combined Load: D + L

Steel Beam Design



STEEL BEAM PRELIMINARY SELECTION

Project: **Office Building - Scheme A**	**Date:** Aug 31, 1994
Location: **Radford AAP**	**Engr:**

CASM Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left)
Roller (Right)
Beam Span: 24.0 ft
Trib Width= 8.0 ft
Depth Limit= **36.0** in. max
Fy= **36.0** ksi
Fb=.66*Fy= 24.0 ksi
Fv= 14.4 ksi
E = 29,000 ksi
Live Ld Defl= **L/360** =0.80 in
Total Defl= **L/240** =1.20 in

Load Combination: D + L

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead		3.6		0.6	0.6
Sup Dead		32.8		5.5	5.5
Live		86.4		14.4	14.4
Lmin Roof					
Snow					
Wind					
Summary		122.8		20.5	20.5

Max: M=	122.8 k-ft	R=	20.5 kips
Sx(req)=	61.4 in^3	Ix(req)=	386.1 in^4

CASM Beam Selection Table:

Beam	Depth d (in)	Width bf (in)	Ix (in^4)	Sx (in^3)	Live Ld Defl (in)	Total Ld Defl (in)	Shear fv (ksi)	Bending fb (ksi)	Beam Wt (lb)
W 14 x 43	13.7	8.00	428	63	-0.72	-1.03	4.9	23.5	1,032
W 12 x 50	12.2	8.08	394	65	-0.78	-1.11	4.5	22.8	1,200
W 16 x 40	16.0	7.00	518	65	-0.60	-0.85	4.2	22.8	960
W 18 x 40	17.9	6.02	612	68	-0.50	-0.72	3.6	21.5	960
W 14 x 48	13.8	8.03	485	70	-0.64	-0.91	4.4	21.0	1,152

CASM Steel Beam Selection:

							Live	Total
W 16 x 40	Span= 24.0 ft	Ix=	518	Sx=	65	Defl(in):	-0.60	-0.85
		fv=	4.2	fb=	22.8	Beam Wt(tons)=		0.48

Notes:

1. Steel beam properties from ASD - AISC Steel Construction Manual, 9th edition

Widely Spaced Element Analysis: Girder

Start

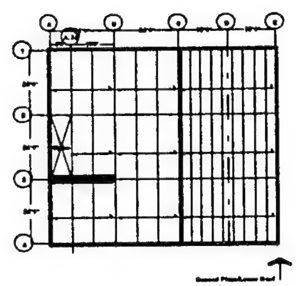
Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Material Steel

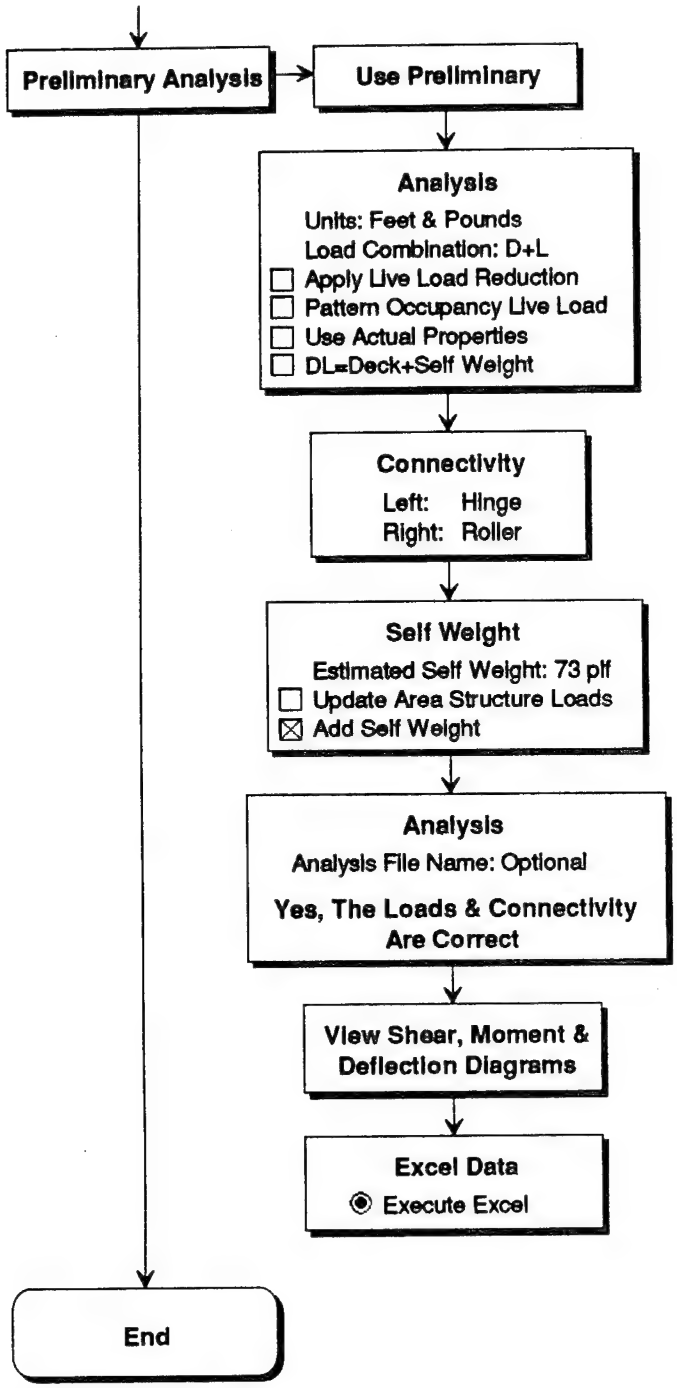
Select Element To Analyze & Design

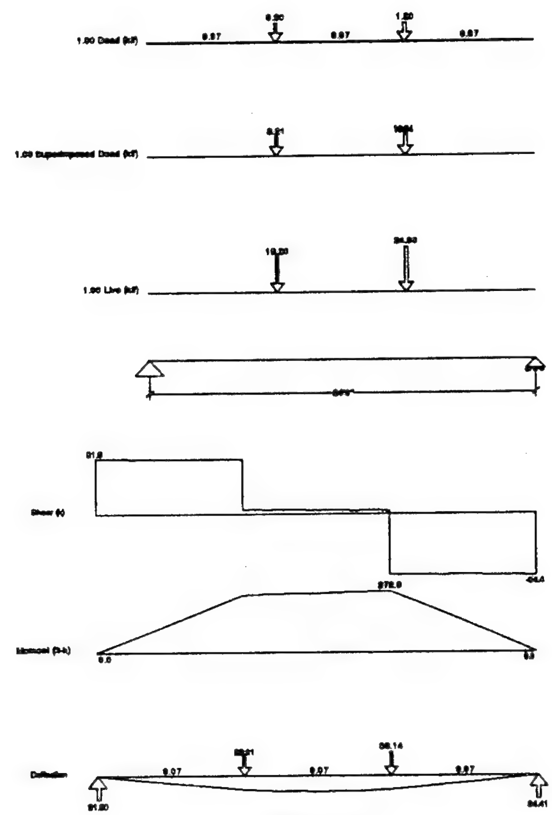
- Linear Widely Spaced Rolled Section
- Select Widely Spaced Element A3-B3
- Review Element Attributes & Guidelines

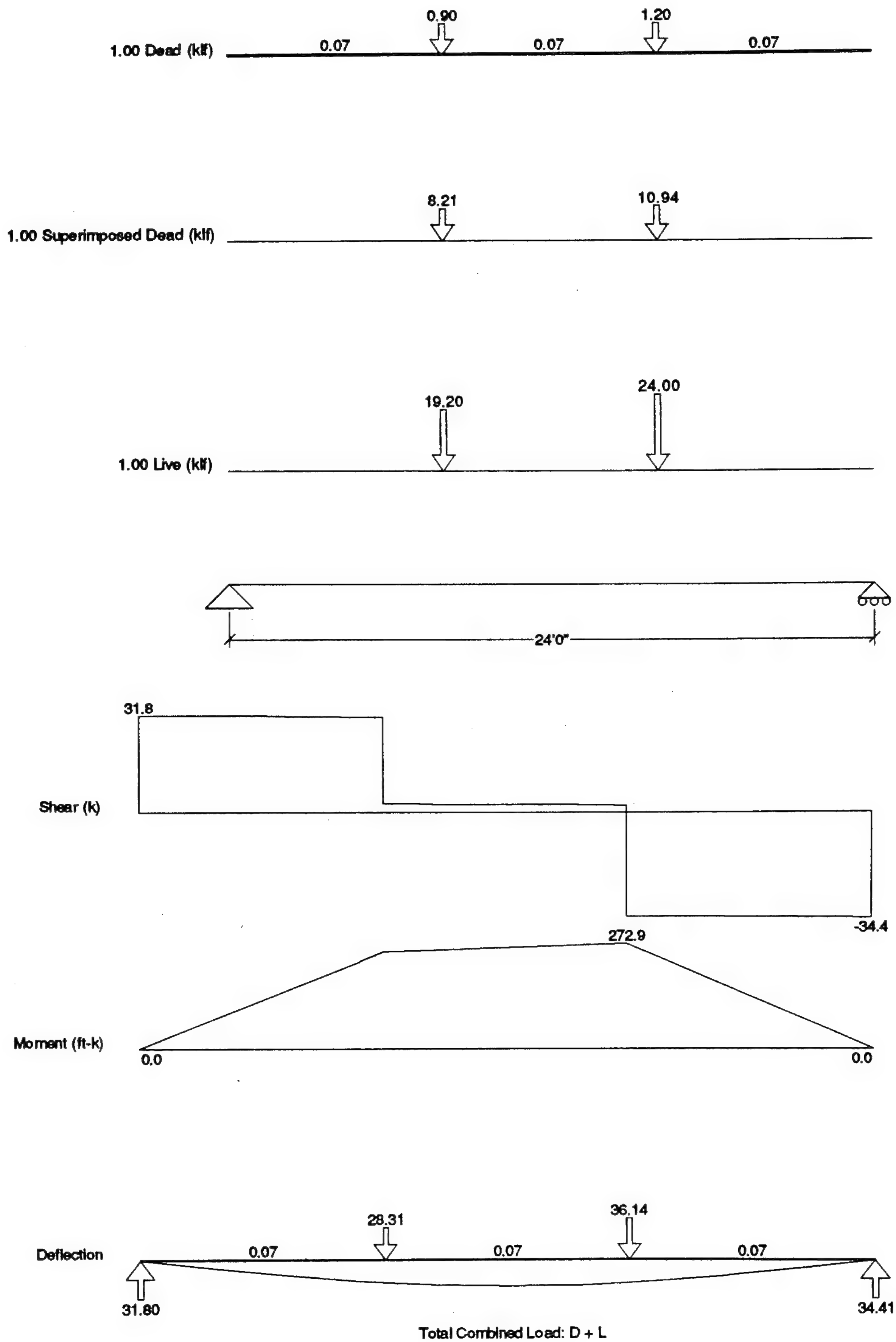


Load Combination D + L

- Use Load Combination
- Set Factors
  - Dead: 1.0
  - Live: 1.0
- Add
- OK Button To Close Dialog Window
- Highlight D+L In List

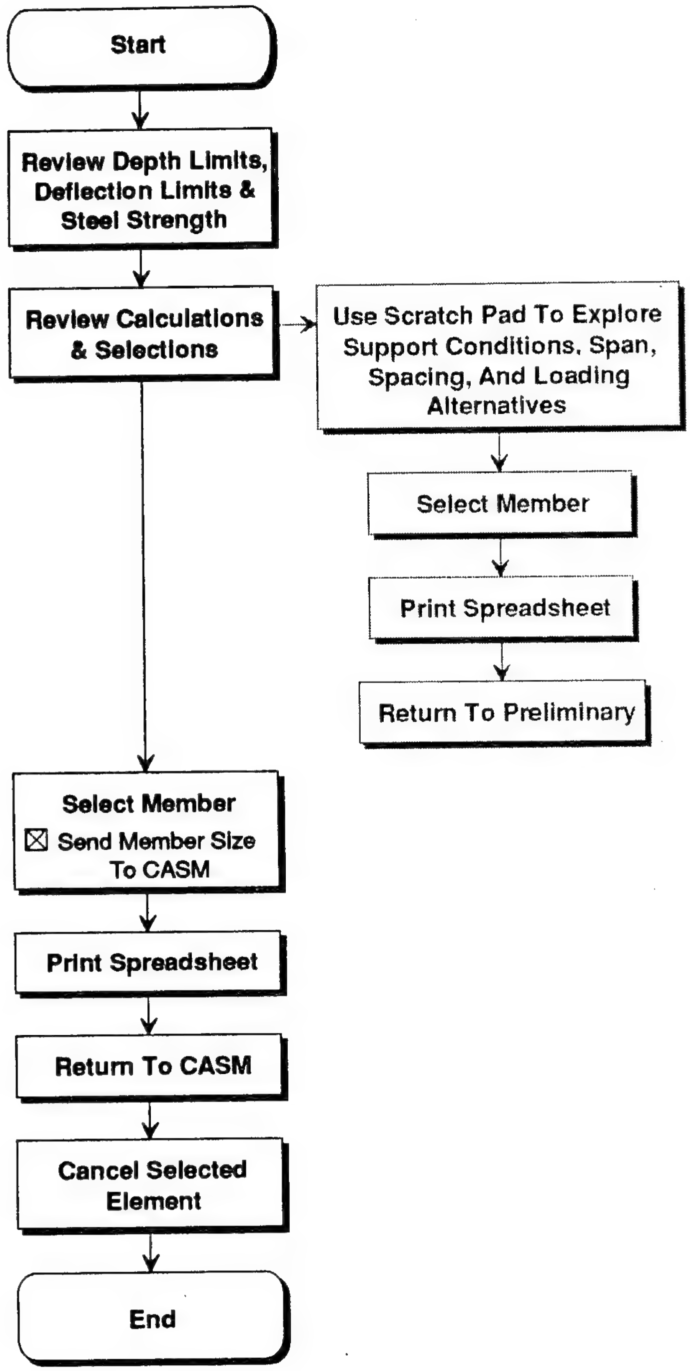

Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+L
☐ Apply Live Load Reduction
☐ Pattern Occupancy Live Load
☐ Use Actual Properties
☐ DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Self Weight
Estimated Self Weight: 73 plf
☐ Update Area Structure Loads
☒ Add Self Weight
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
◉ Execute Excel
End





0.90
1.20
1.00 Dead (klf)
0.07
0.07
0.07
8.21
10.94
1.00 Superimposed Dead (klf)
24.00
19.20
1.00 Live (klf)
24'0"
31.8
Shear (k)
-34.4
272.9
Moment (ft-k)
0.0
0.0
36.14
28.31
Deflection
0.07
0.07
0.07
31.80
34.41
Total Combined Load: D + L

Steel Beam Design



STEEL BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme A	**Date:** Aug 31, 1994
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left)
Roller (Right)
Beam Span: 24.0 ft
Trib Width= 12.0 ft
Depth Limit= **36.0** in. max
Fy= **36.0** ksi
Fb=.66*Fy= 24.0 ksi
Fv= 14.4 ksi
E = 29,000 ksi
Live Ld Defl= **L/360** =0.80 in
Total Defl= **L/240** =1.20 in

Load Combination: D + L

	Factored Moments (k-ft)			Fact. Reactions	
Load Type	Left	Mid	Right	Left(k)	Right(k)
Dead		13.7		1.9	2.0
Sup Dead		80.3		9.1	10.0
Live		179.2		20.8	22.4
Lmin Roof					
Snow					
Wind					
Summary		272.9		31.8	34.4

Max: M=	272.9 k-ft	R=	34.4 kips
Sx(req)=	136.5 in^3	Ix(req)=	789.4 in^4

CASM Beam Selection Table:

Beam	Depth d (in)	Width bf (in)	Ix (in^4)	Sx (in^3)	Live Ld Defl (in)	Total Ld Defl (in)	Shear fv (ksi)	Bending fb (ksi)	Beam Wt (lb)
W 21 x 68	21.1	8.27	1,480	140	-0.43	-0.65	3.8	23.4	1,632
W 14 x 90	14.0	14.52	999	143	-0.63	-0.96	5.6	22.9	2,160
W 12 x 106	12.9	12.22	933	145	-0.68	-1.03	4.4	22.6	2,544
W 18 x 76	18.2	11.04	1,330	146	-0.47	-0.72	4.4	22.4	1,824
W 21 x 73	21.2	8.30	1,600	151	-0.39	-0.60	3.6	21.7	1,752

CASM Steel Beam Selection:

				Live / Total
	Span= 24.0 ft	Ix=	Sx=	Defl(in):
		fv=	fb=	Beam Wt(tons)=

Notes:
1. Steel beam properties from ASD - AISC Steel Construction Manual, 9th edition

Truss Element Analysis

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

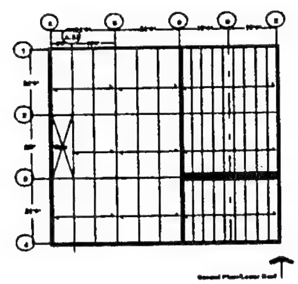
Material Steel

Select Element To Analyze & Design

Linear Truss-Custom

Select A Truss

Review Element Attributes & Guidelines



Compare Min. Roof LL & Snow Loads

Use Compare Min. Roof LL & Snow Loads

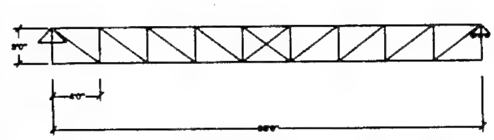
Analysis
Units: Feet & Pounds

Connectivity
Left: Hinge
Right: Roller

Truss - Custom

Pratt
Top Chord Panels: 9
Depth At Supports: 3'
Scissors Height: 0'

☐ Verticals
☐ Start At Bottom
☒ Left Support At Top
☒ Right Support At Top



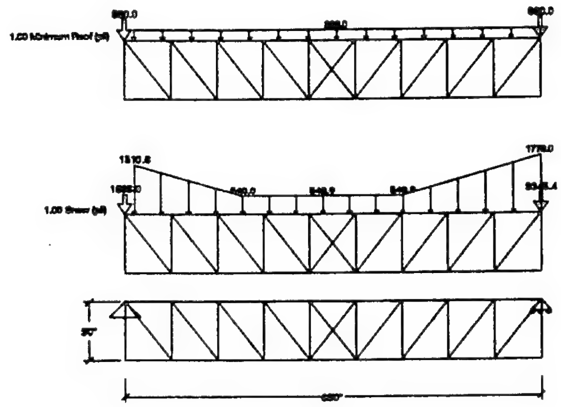
Compare Min. Roof LL & Snow Loads

Snow Load Options
◉ Combined Snow Loads

Minimum Roof (LL)

Compare Min. Roof LL & Snow Loads

View Shear, Moment & Deflection Diagrams



Load Combination D + S

Use Load Combination

Set Factors
Dead: 1.0
Snow: 1.0

Add

OK Button To Close Dialog Window

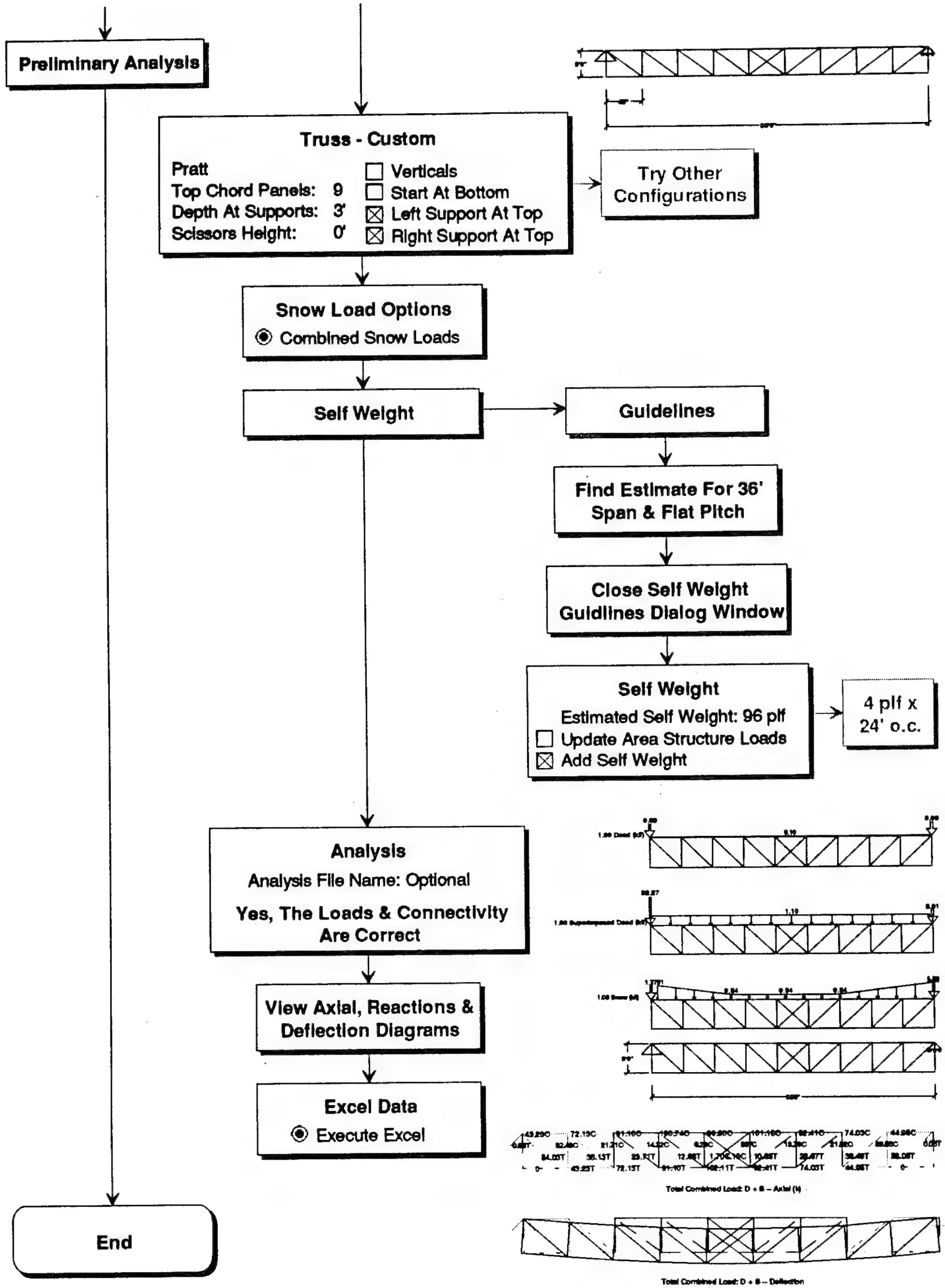
Highlight D+S In List

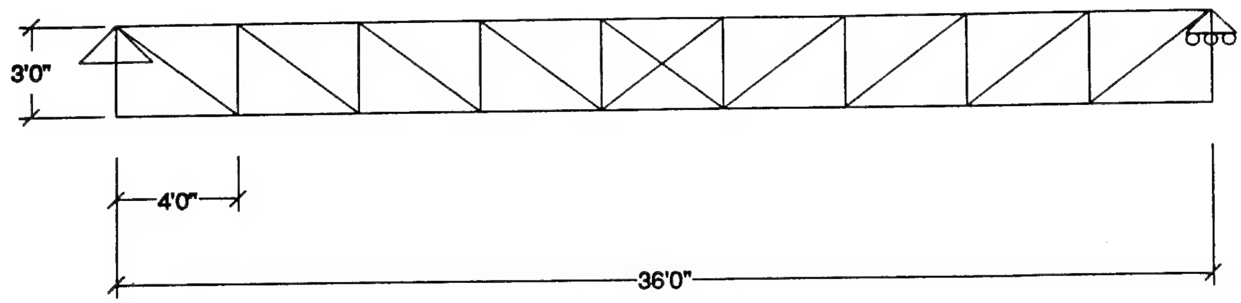
Preliminary Analysis

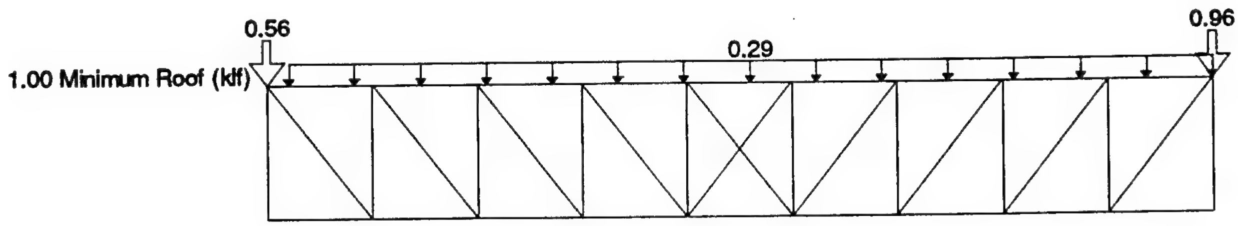
Use Preliminary

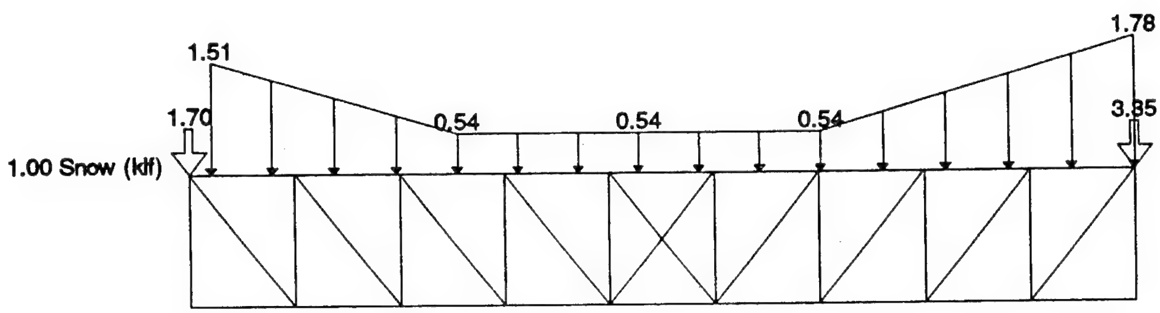
Analysis
Units: Feet & Pounds
Load Combination: D+S
☐ Use Actual Properties
☐ DL=Deck+Self Weight

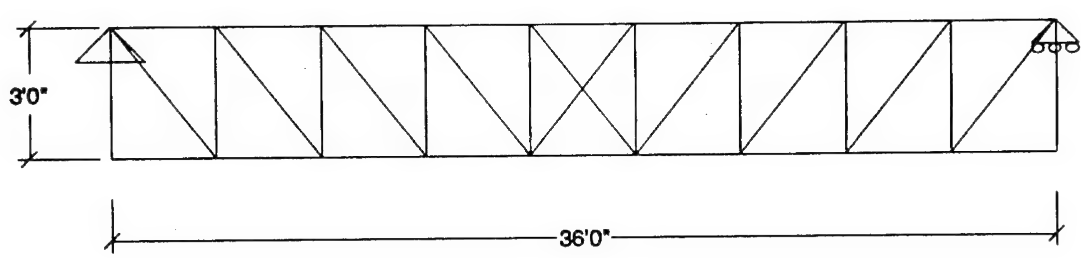
Connectivity
Left: Hinge
Right: Roller


Preliminary Analysis
Truss - Custom
Pratt
Top Chord Panels: 9
Depth At Supports: 3'
Scissors Height: 0'
Verticals
Start At Bottom
Left Support At Top
Right Support At Top
Try Other Configurations
Snow Load Options
Combined Snow Loads
Self Weight
Guidelines
Find Estimate For 36' Span & Flat Pitch
Close Self Weight Guidlines Dialog Window
Self Weight
Estimated Self Weight: 96 plf
Update Area Structure Loads
Add Self Weight
4 plf x 24' o.c.
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Axial, Reactions & Deflection Diagrams
Excel Data
Execute Excel
End
Total Combined Load: D + S – Axial (k)
Total Combined Load: D + S – Deflection


3'0"
4'0"
36'0"


0.56
0.29
0.96
1.00 Minimum Roof (klf)


1.51
1.78
1.70
0.54
0.54
0.54
3.35
1.00 Snow (klf)

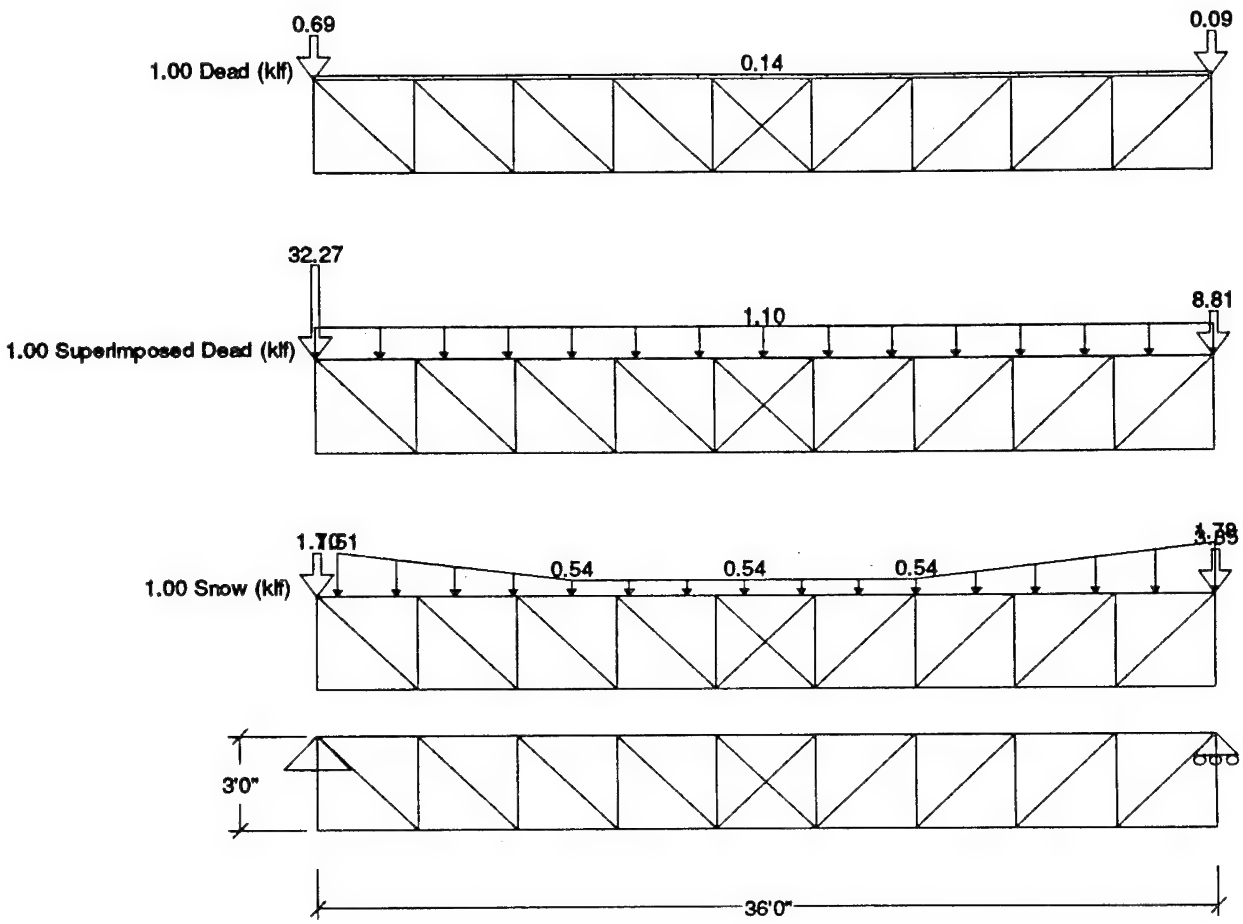

3'0"
36'0"

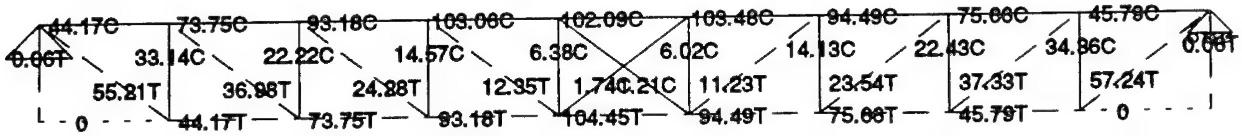
```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Wed Aug 31, 1994  11:27 AM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 144.0 sqft
Roof Slope      (F) : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200         R1 = 1.00
F <= 4            R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 20.00 psf      |
+-------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.


Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Wed Aug 31, 1994  11:27 AM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 48.0 sqft
Roof Slope      (F) : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200         R1 = 1.00
F <= 4            R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf
+-------------------------+
|     Lr = 20.00 psf      |
+-------------------------+
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof
decking and rafters, a concentrated live load with 250 lbs uniformly
distributed over an area of 2.0 ft square (4.0 sqft) will be included.
The concentrated load will be located so as to produce the maximum
stress in the member.


Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Wed Aug 31, 1994  11:27 AM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At) : 1056.0 sqft
Roof Slope      (F) : 0.00 in 12

Lr = 20*R1*R2 >= 12
```

```
At >= 600          R1 = 0.60
F <= 4             R2 = 1.00
Lr = 12.00 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 12.00 psf     |
+------------------------+
```

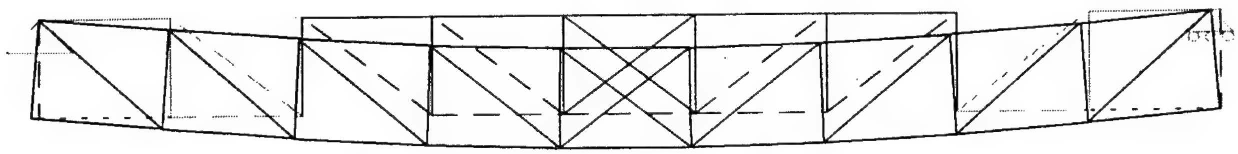
Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

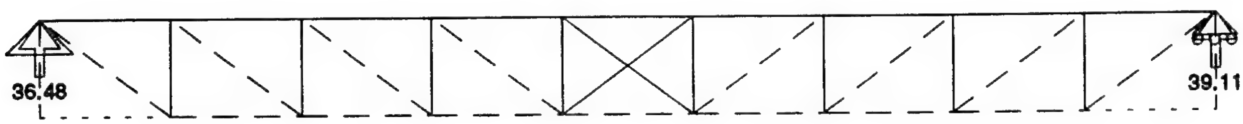




Total Combined Load: D + S -- Axial (k)

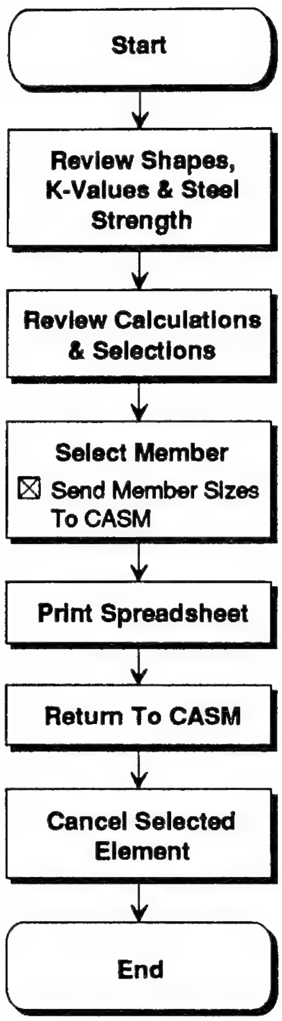


Total Combined Load: D + S -- Deflection



Total Combined Load: D + S -- Reactions (k)

Steel Truss Design



STEEL TRUSS PRELIMINARY DESIGN

Project: Office Building - Scheme A	**Date:** Aug 31, 1994
Location: Radford AAP	**Engr:**

Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left), Roller (Right)
Truss Span: 12.25 ft
Spacing: 24.00 ft
Fy= **36.0** ksi
Ft= 21.6 ksi
E= 29,000 ksi
Cc= 126.1

Load Combination: D + S

Load Type	Top Chord	Bottom Chord	Tens. Web	Comp. Web
Dead	7.5	-7.6	-3.8	2.3
Sup Dead	59.0	-59.8	-30.0	18.0
Live				
Lmin Roof				
Snow	37.0	-37.1	-23.4	14.1
Wind				
Summary	103.5	-104.5	-57.2	34.4
Length	4.00	4.00	5.00	3.00

Truss Member Design Table:

Member Size	As (in^2)	rx (in)	ry (in)	Kl/r	Fa (psi)	fa (psi)	Mbr Wt(plf)
Top Chord **K=1.0**					**Shape Selection:**		**WT**
WT 8 x 18	5.28	2.41	1.52	31.58	19.8	19.6	18.0
WT 7 x 19	5.58	2.04	1.55	30.97	19.9	18.5	19.0
WT 5 x 19.5	5.73	1.24	1.98	38.71	19.3	18.1	19.5
Bottom Chord **K=1.0**					**Shape Selection:**		**WT**
WT 5 x 16.5	4.85	1.26	1.94	38.10	21.6	21.5	16.5
WT 7 x 17	5.00	2.04	1.53	31.37	21.6	20.9	17.0
WT 4 x 17.5	5.14	0.97	2.03	49.64	21.6	20.3	17.5
Tension Web **K=1.0**					**Shape Selection:**		**2L**
2L 2 x 2 x 3/8	2.72	0.59	0.87	101.01	21.6	21.0	9.4
2L 3.5 x 2.5 x 1/4	2.88	1.12	0.96	62.63	21.6	19.9	9.8
2L 3 x 3 x 1/4	2.88	0.93	1.26	64.52	21.6	19.9	9.8
Comp Web **K=1.0**					**Shape Selection:**		**2L**
2L 3 x 2.5 x 3/16	1.99	0.95	0.99	37.74	19.4	17.3	6.8
2L 2.5 x 3 x 3/16	1.99	0.76	1.30	47.31	18.6	17.3	6.8
2L 2.5 x 2 x 1/4	2.13	0.78	0.80	45.92	18.7	16.1	7.2

CASM Steel Truss Member Selection:

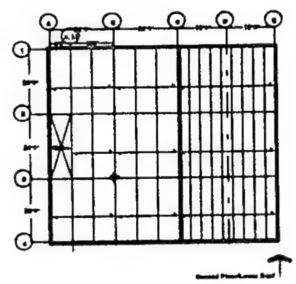
Top Chord:	Kl/r=	31.6	As=	5.3	Tension Web Mbr:	Kl/r= 101.0		As= 2.7
WT 8 x 18	fa=	19.6 <	Fa=	19.8	**2L 2 x 2 x 3/8**	fa= 21.0	<	Fa= 21.6
Bottom Chord:	Kl/r=	38.1	As=	4.9	Compression Web Mbr:	Kl/r= 37.7		As= 2.0
WT 5 x 16.5	fa=	21.5 <	Fa=	21.6	**2L 3 x 2.5 x 3/16**	fa= 17.3	<	Fa= 19.4

Notes:

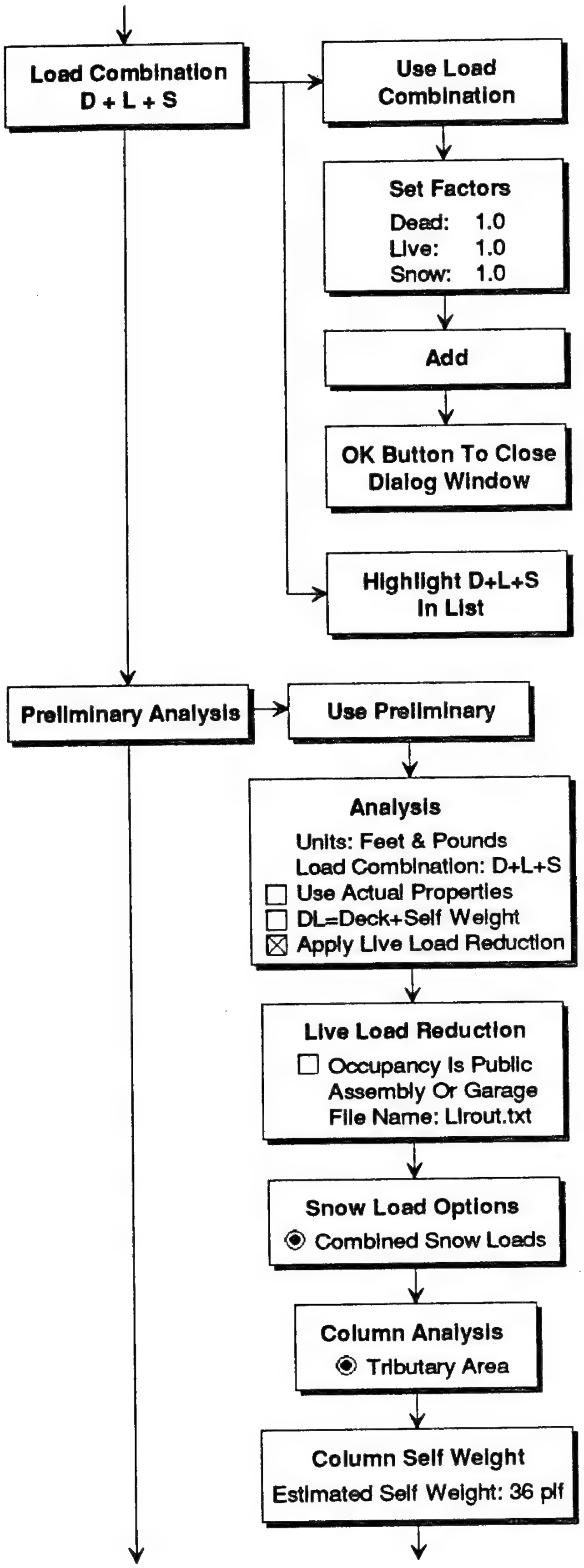
1. Steel member properties from ASD - AISC Steel Construction Manual, 9th edition

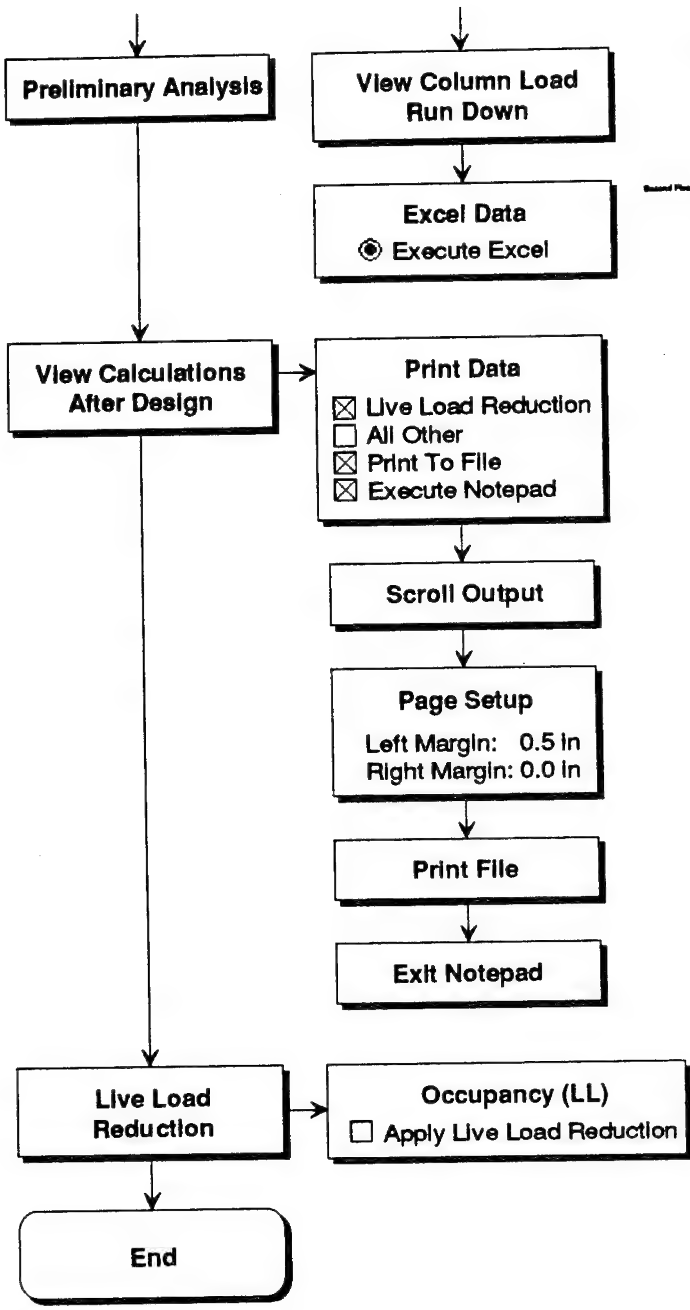
Column Load Run Down

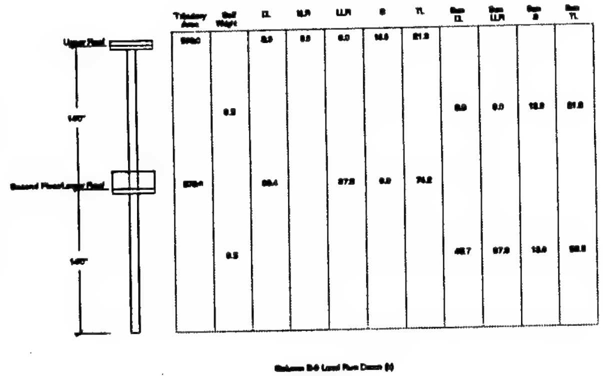
- Start
- Use Loads & Design Tool Palette
- Material Steel
- Live Load Reduction
  - Occupancy (LL)
    ☒ Apply Live Load Reduction
- Select Element To Analyze & Design
  - Column Rolled Section
  - Select Column B3
  - Review Element Attributes & Guidelines

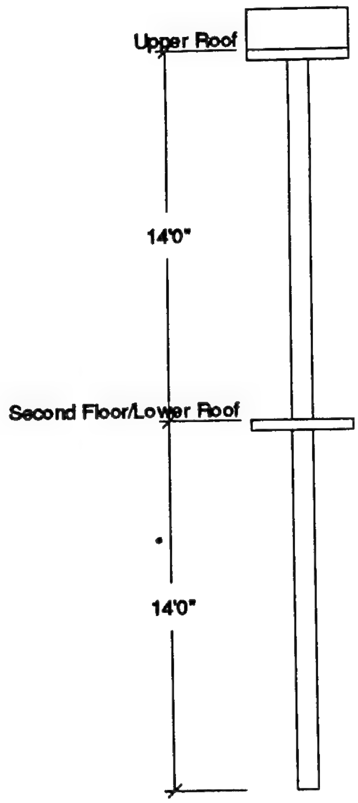


- Compare Min. Roof LL & Snow Loads
  - Use Compare Min. Roof LL & Snow Loads
  - Analysis
    Units: Feet & Pounds
  - Snow Load Options
    ◉ Combined Snow Loads
  - Minimum Roof (LL)
  - Column Analysis
    ◉ Tributary Area
  - Compare Min. Roof LL & Snow Loads


Load Combination
D + L + S
Use Load Combination
Set Factors
Dead: 1.0
Live: 1.0
Snow: 1.0
Add
OK Button To Close Dialog Window
Highlight D+L+S In List
Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Load Combination: D+L+S
Use Actual Properties
DL=Deck+Self Weight
Apply Live Load Reduction
Live Load Reduction
Occupancy Is Public Assembly Or Garage
File Name: Llrout.txt
Snow Load Options
Combined Snow Loads
Column Analysis
Tributary Area
Column Self Weight
Estimated Self Weight: 36 plf


Preliminary Analysis
View Column Load Run Down
Excel Data
Execute Excel
View Calculations After Design
Print Data
Live Load Reduction
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
Live Load Reduction
Occupancy (LL)
Apply Live Load Reduction
End





Tributary Area	Lr	S	Sum Lr	Sum S
576.0	7.2	13.0		
			7.2	13.0
576.0	0.0	0.0		
			7.2	13.0

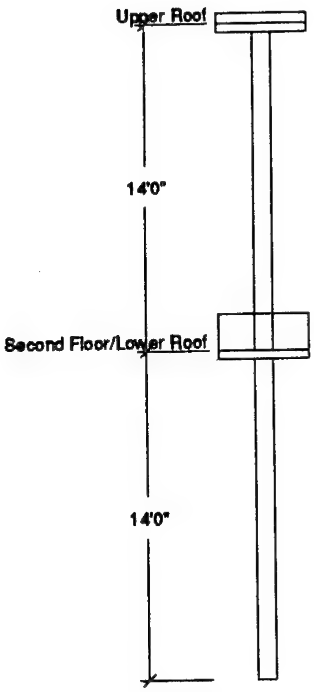
Column B-3 Load Run Down (k)

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Wed Aug 31, 1994   12:23 PM

*********************** Minimum Roof Live Load (Lr) ***********************

Tributary Area (At)  : 576.0 sqft
Roof Slope     (F)   : 0.00 in 12

Lr = 20*R1*R2 >= 12
200 < At < 600   R1 = 1.2-0.001*At
                 R1 = 0.624
F <= 4           R2 = 1.00
Lr = 12.48 psf
Minimum Lr = 12.0 psf
+------------------------+
|     Lr = 12.48 psf     |
+------------------------+
```

Check minimum roof live load, Lr, against minimum snow design loads.

Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

Column Load Run Down

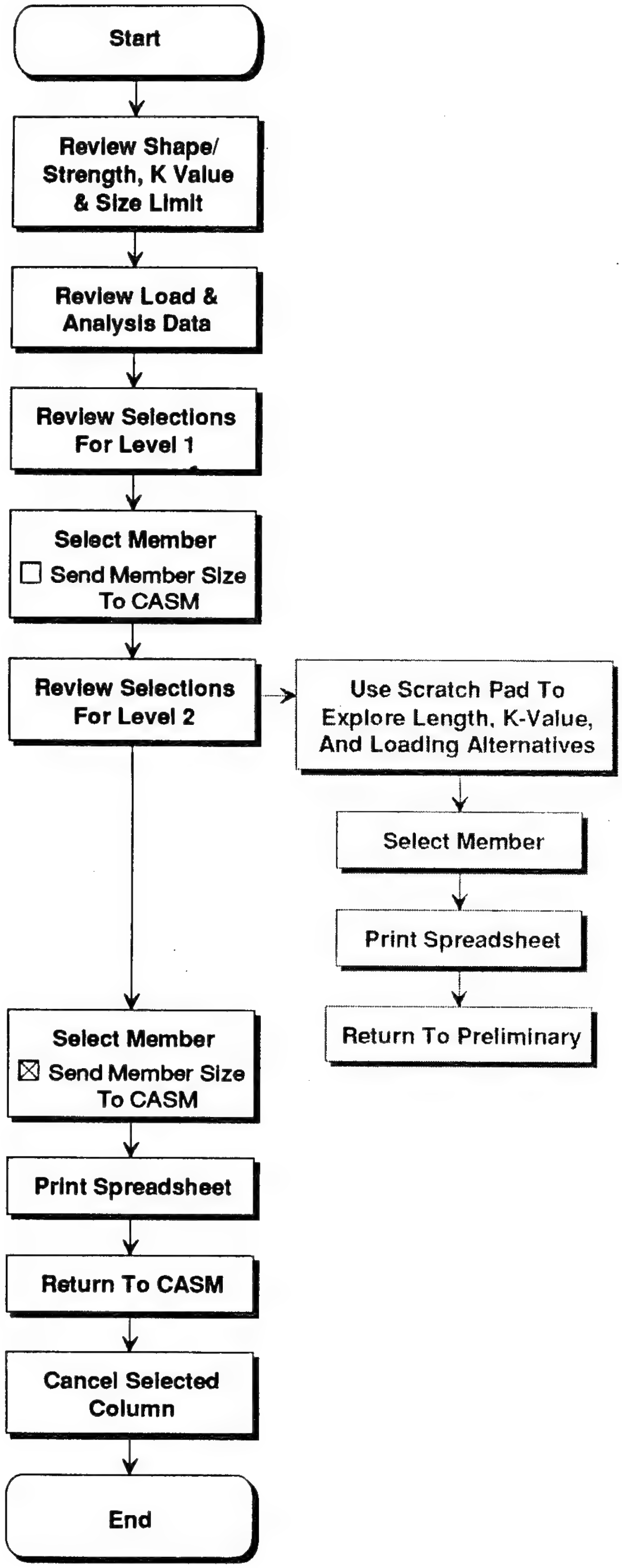


Tributary Area	Self Weight	DL	LLR	LLR	S	TL	Sum DL	Sum LLR	Sum S	Sum TL
576.0		8.3	0.0	0.0	13.0	21.3				
	0.5						8.8	0.0	13.0	21.8
576.0		36.4		37.8	0.0	74.2				
	0.5						45.7	37.8	13.0	96.5

Column B-3 Load Run Down (k)

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Design Load  : TM 5-809-1 1992
Time         : Wed Aug 31, 1994  12:25 PM

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Office: Offices (Lo) :   50.0 psf
Tributary area  (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 28.1 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 25.0 psf
+-------------------------+
|     L = 28.13 psf       |
+-------------------------+

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Corridor: Main          (Lo) :  100.0 psf
Tributary area          (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 56.3 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 50.0 psf
+-------------------------+
|     L = 56.25 psf       |
+-------------------------+

*************************** Live Load Reduction ***************************

Second Floor/Lower Roof
Files & Storage         (Lo) :  150.0 psf
Tributary area          (TA) :  576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
Lo > 100.0 psf
Member supports only one floor.
No live load reduction taken.
L = Lo
+-------------------------+
|     L = 150.00 psf      |
+-------------------------+
```

Steel Column Design



STEEL COLUMN PRELIMINARY SELECTION

Project: Office Building - Scheme A **Location: Radford AAP**	**Date:** Aug 31, 1994 **Engr:**

CASM Load & Analysis Data:

Method: Analysis Load Combination: D + L + S Steel Fy= **36.0** ksi
Member ID: B-3 Size Limit= **10.0** in. max E= 29000 ksi

Name	Level	Flr to Flr Ht	Trib Area	Floor Level Load Totals (kips) Dead	Live	Lmin	Snow	Wind	Load Totals
	6								
	5								
	4								
	3								
Upper Roof	2	14.0	576	8.8			13.0		21.8
Second Floor/L	1	14.0	576	45.7	37.8		13.0		96.5

CASM Column Selection Table

Level: **2** Preq: 21.76 kips K-value: **1.0** Cc= 126.1
Col Shape: **W** Length: 14.0 ft kl: 14.0

Column Size	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	fa (ksi)	Pallow (kip)	Weight (ton)
W 6 x 15	5.99	5.99	4.43	1.46	115.07	10.98	4.91	48.6	0.11
W 5 x 16	5.01	5.00	4.68	1.27	132.28	8.45	4.65	39.6	0.11
W 5 x 19	5.15	5.03	5.54	1.28	131.25	8.61	3.93	47.7	0.13
W 6 x 20	6.20	6.02	5.87	1.50	112.00	11.40	3.71	66.9	0.14
W 8 x 28	8.06	6.54	8.25	1.62	103.70	12.50	2.64	103.2	0.20

CASM Steel Column Selection

Column Size	Level	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	Pallow (kip)	Weight (ton)
W 8 x 28	2	8.06	6.54	8.25	1.62	103.70	12.50	103.2	0.20
W 8 x 28	1	8.06	6.54	8.25	1.62	103.70	12.50	103.2	0.20
								Total Column Weight:	0.39

Notes:

1. Steel column properties from ASD - AISC Steel Construction Manual, 9th edition

Lateral Resistance Philosophy

Steps Required

1. Create building volume

2. Define a structural grid

3. Layout structural framing on ALL levels

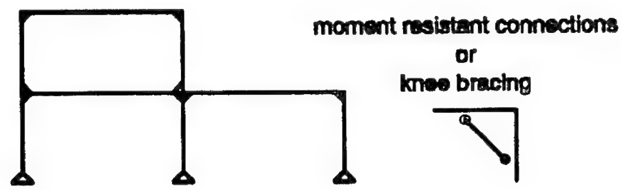
4. Assign gravity load on ALL levels
   Calculate wind and/or seismic loads

5. Select a load combination including wind or seismic loads

6. Define N-S & E-W vertical resistance system

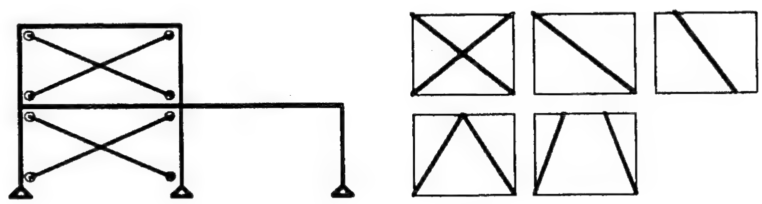
   Options:

   1. Unbraced Frames

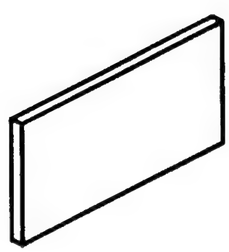


   2. Braced Frames

      A. Trussing



      B. Shear Walls

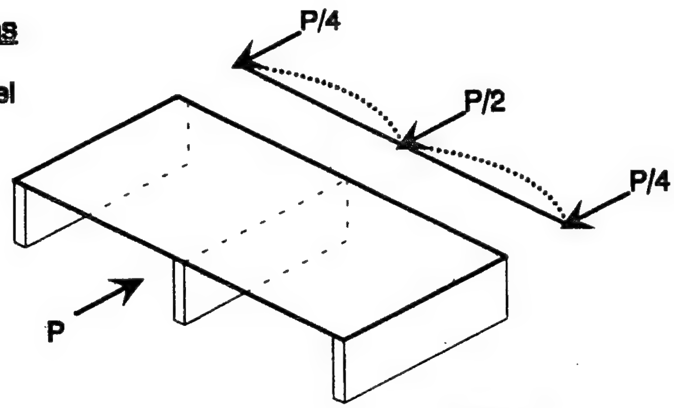


7. Define horizontal diaphragm systems

   All flexible
   All rigid
   Floors rigid & roof flexible

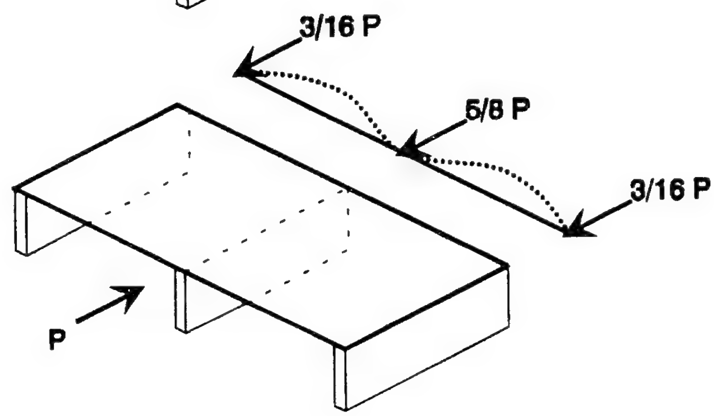
Flexible Diaphragms

Simple Beam Model
(tributary area)



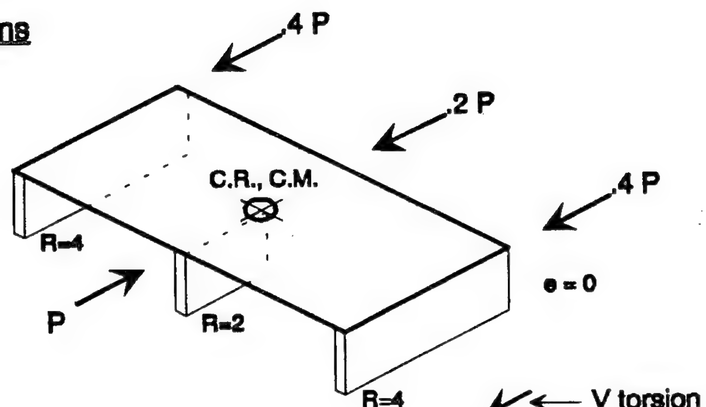
* No Torsion

Continuous Beam Model



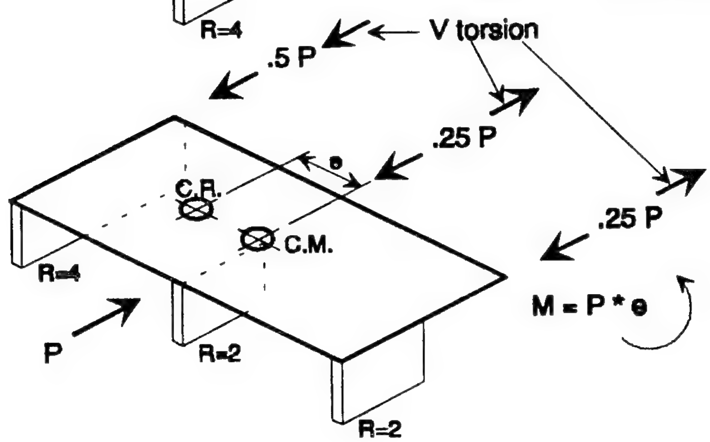
Rigid Diaphragms

Symmetrical

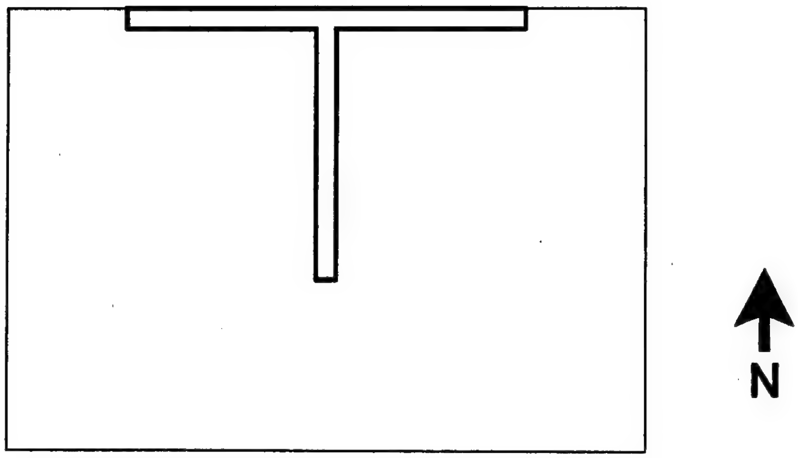


Torsion
(even accidental minimum required)

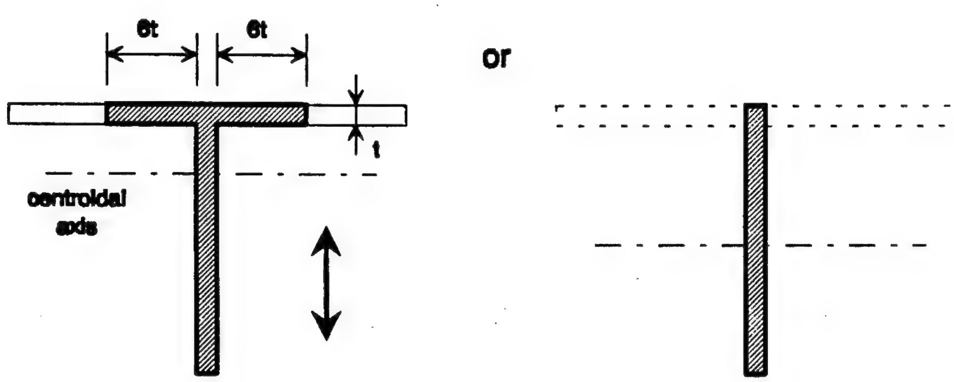
Non-Symmetrical



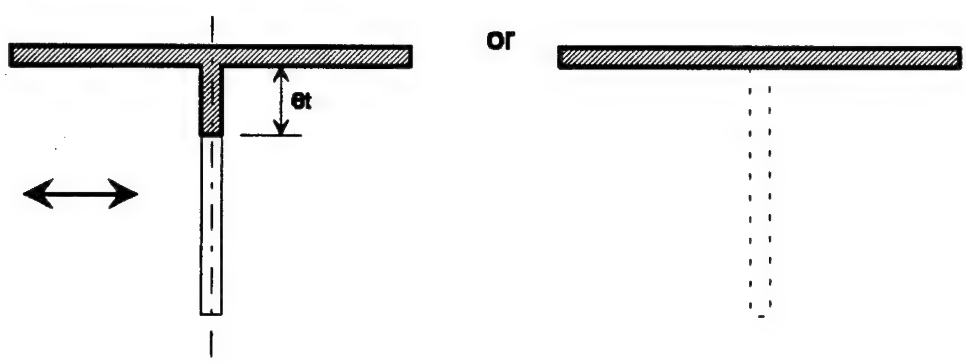
Monolithic Perpendicular Shear Walls



For N-S



For E-W



Define Lateral Resistance

Start

Use Draw Structure Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Define Second Floor/ Lower Roof Diaphragm Type

Diaphragm Guidlines

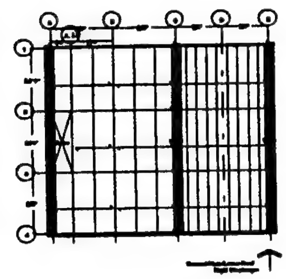
Lateral Horizontal Rigid Diaphragm

Define N-S Lateral Resistance

Define Location

Vertical Define Location

Select Beam On Grid Line A

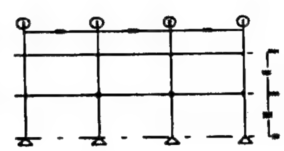


Define Bracing & Connectivity

Vertical Define Elements

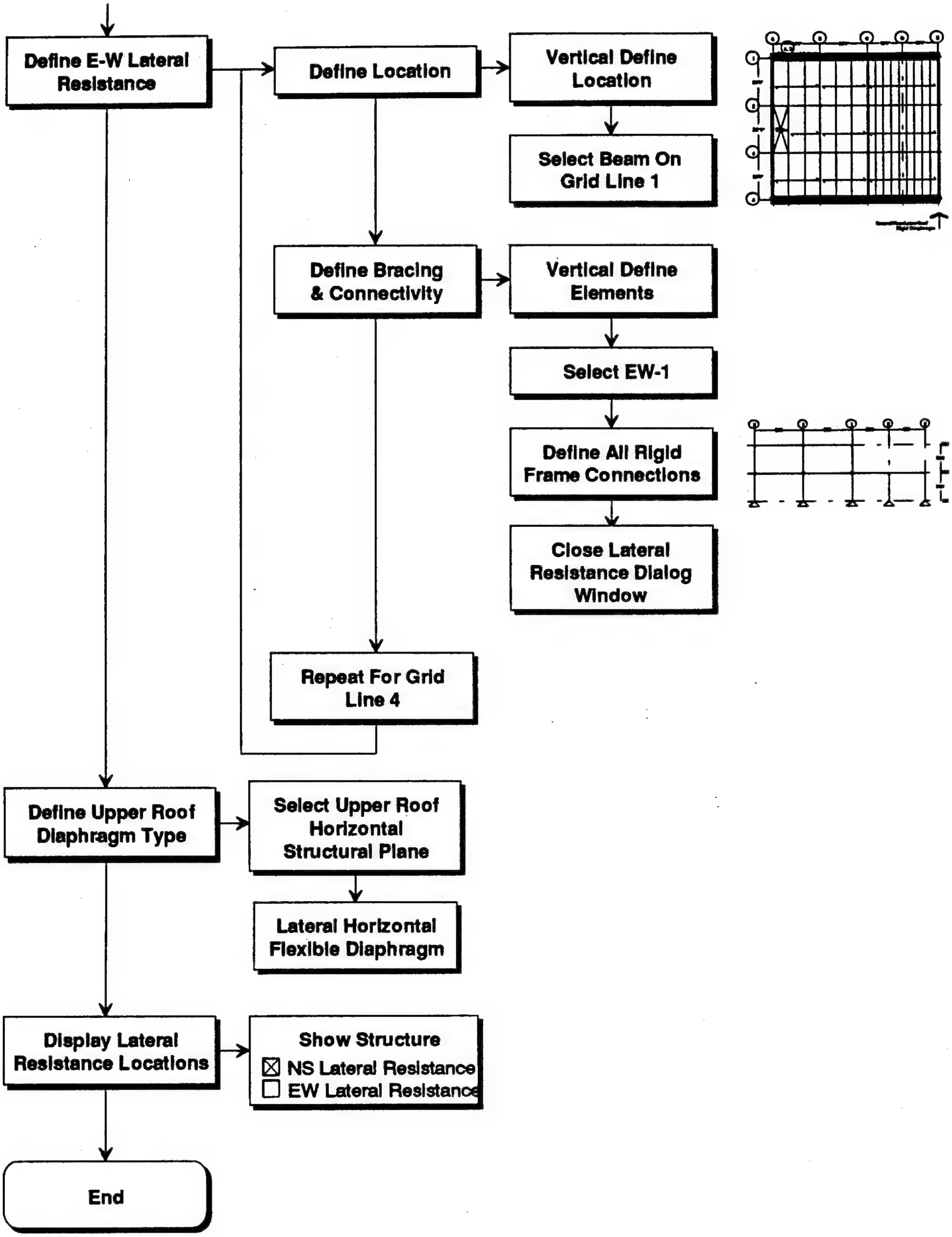
Select NS-1

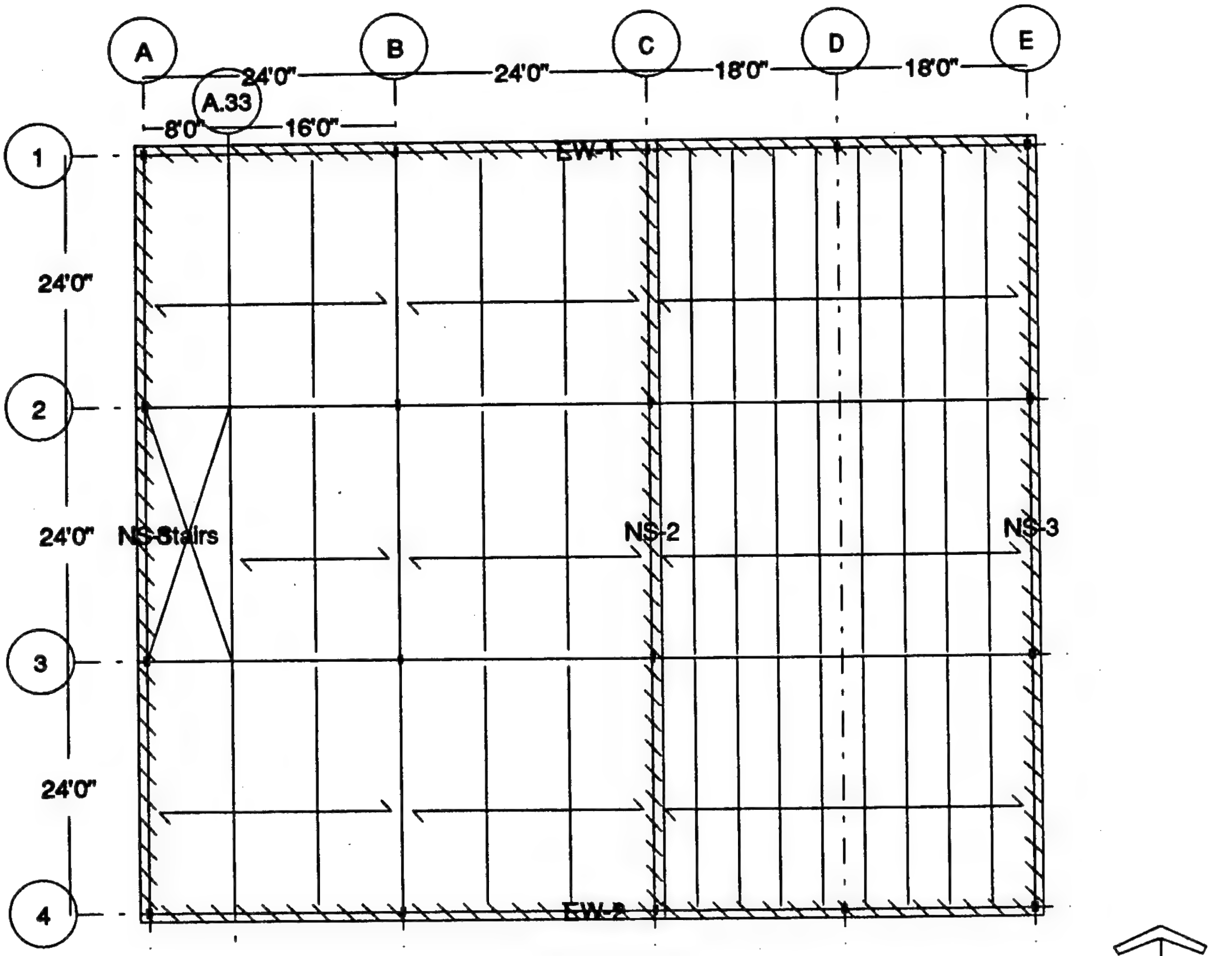
Define All Rigid Frame Connections



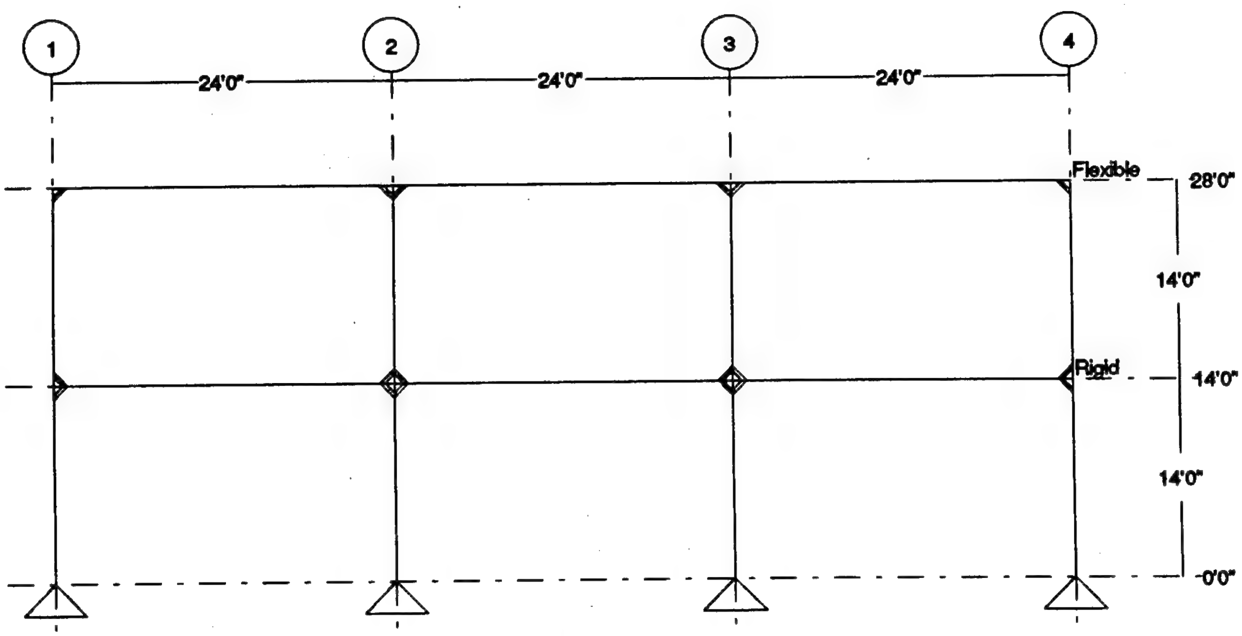
Close Lateral Resistance Dialog Window

Repeat For Grid Lines C & E

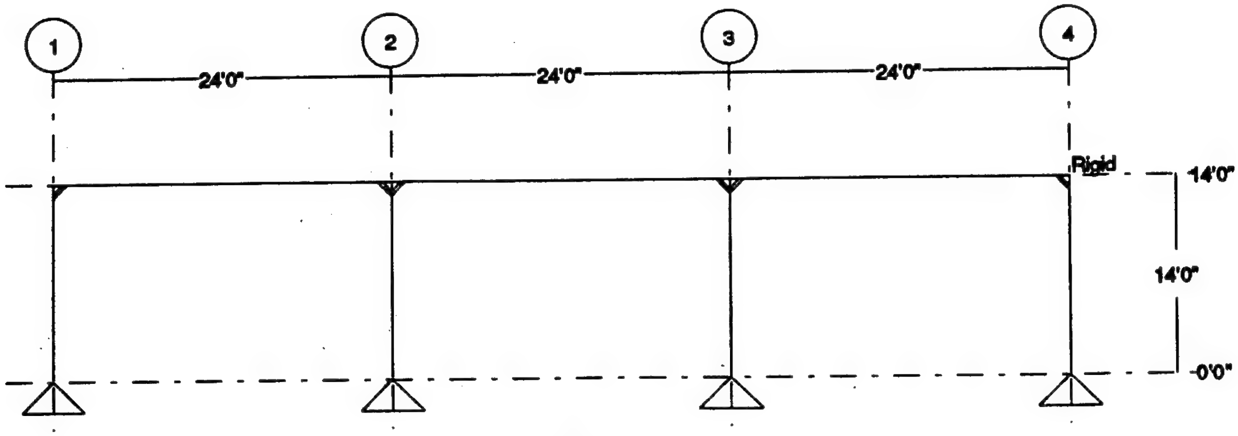

Define E-W Lateral Resistance
Define Location
Vertical Define Location
Select Beam On Grid Line 1
Define Bracing & Connectivity
Vertical Define Elements
Select EW-1
Define All Rigid Frame Connections
Close Lateral Resistance Dialog Window
Repeat For Grid Line 4
Define Upper Roof Diaphragm Type
Select Upper Roof Horizontal Structural Plane
Lateral Horizontal Flexible Diaphragm
Display Lateral Resistance Locations
Show Structure
☒ NS Lateral Resistance
☐ EW Lateral Resistance
End



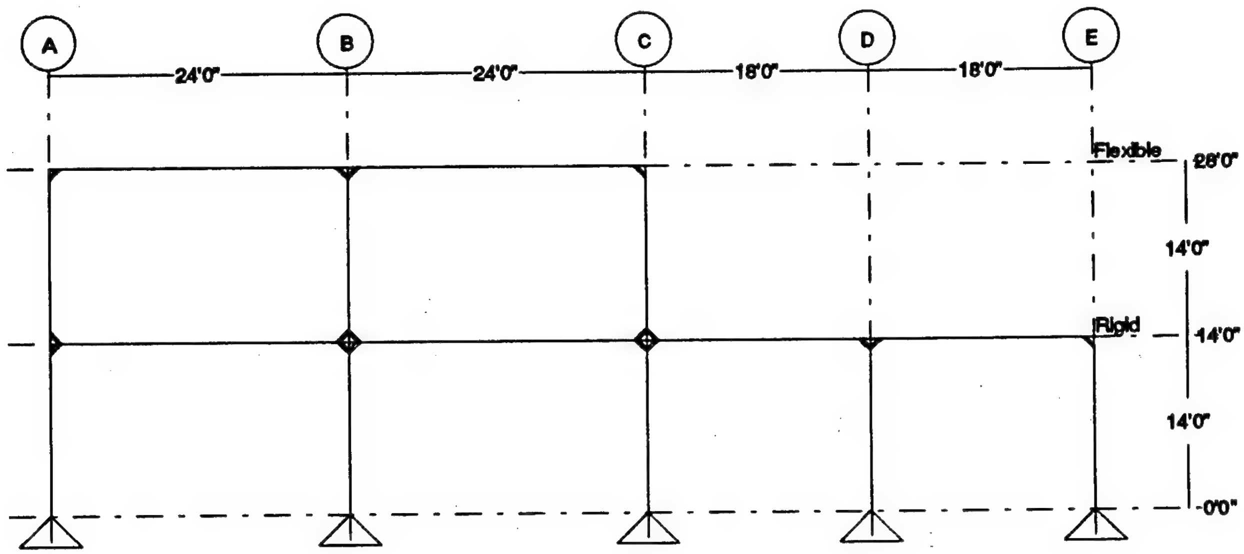
Second Floor/Lower Roof
Rigid Diaphragm



NS-1 & NS-2

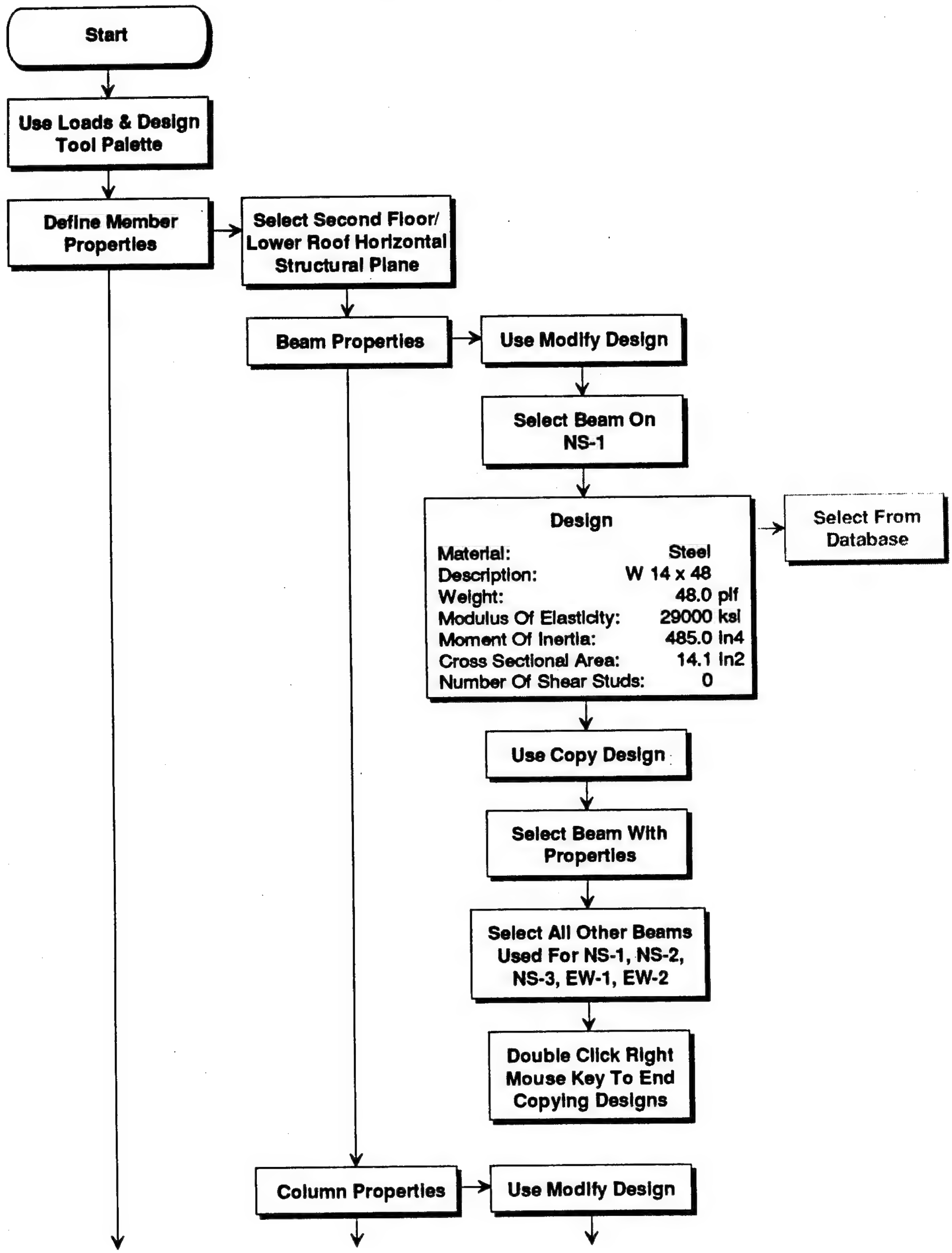

1
2
3
4
24'0"
24'0"
24'0"
Rigid
14'0"
14'0"
-0'0"

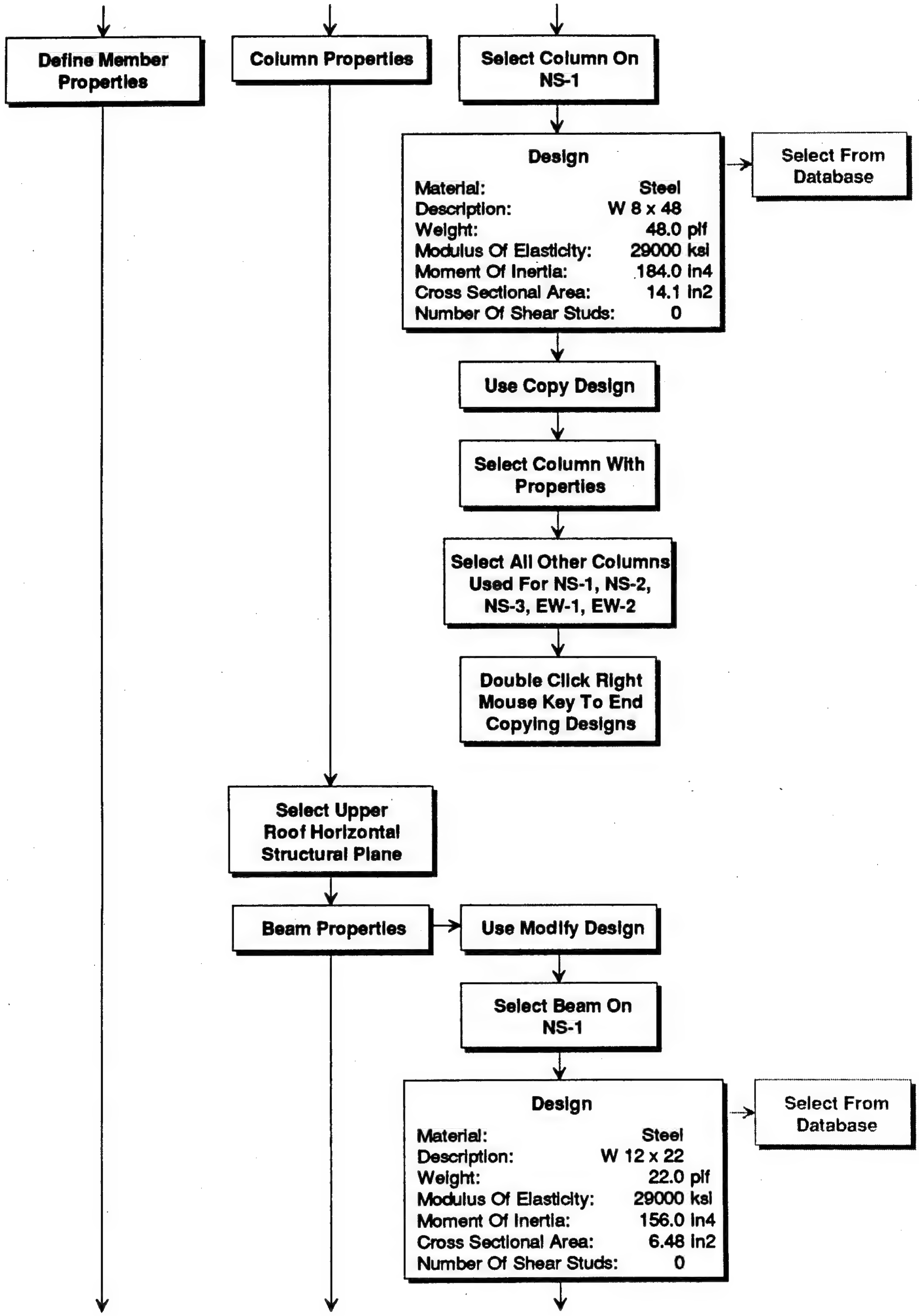
NS-3


A
B
C
D
E
24'0"
24'0"
18'0"
18'0"
Flexible
28'0"
14'0"
Rigid
14'0"
14'0"
-0'0"

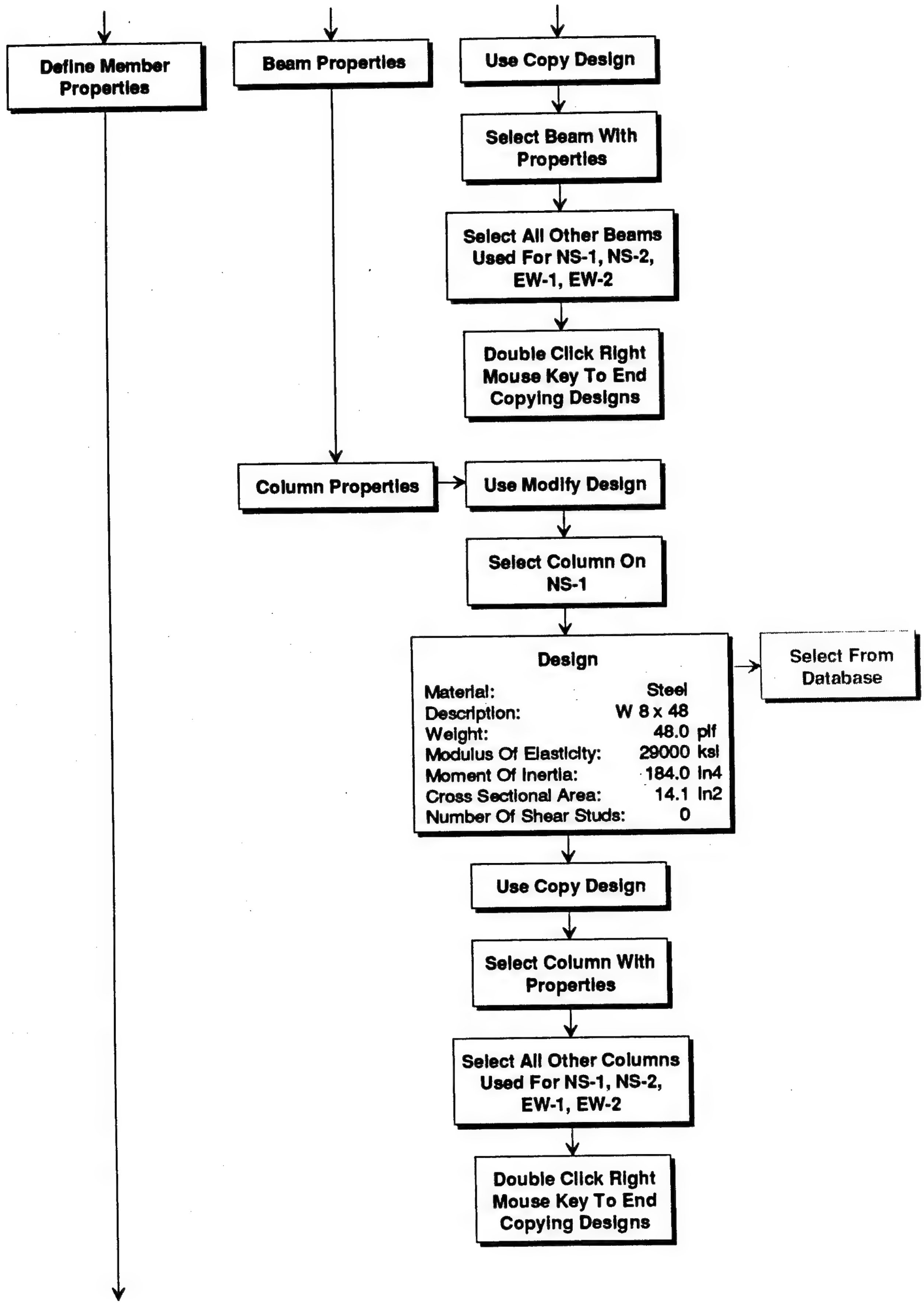
EW-1 & EW-2

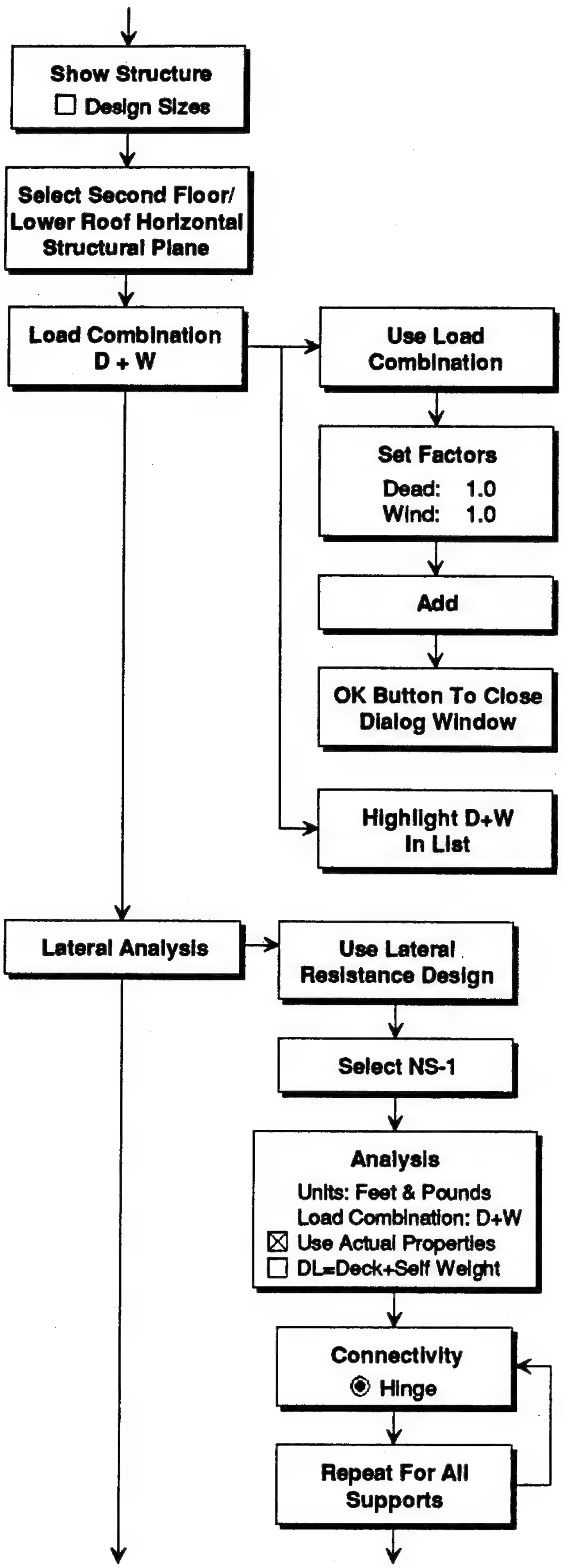
Wind Lateral Analysis





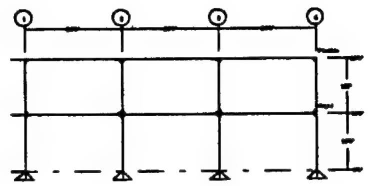
Define Member Properties
Column Properties
Select Column On NS-1
Design
Material: Steel
Description: W 8 x 48
Weight: 48.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 184.0 in4
Cross Sectional Area: 14.1 in2
Number Of Shear Studs: 0
Select From Database
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, NS-3, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
Select Upper Roof Horizontal Structural Plane
Beam Properties
Use Modify Design
Select Beam On NS-1
Design
Material: Steel
Description: W 12 x 22
Weight: 22.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 156.0 in4
Cross Sectional Area: 6.48 in2
Number Of Shear Studs: 0
Select From Database


Define Member Properties
Beam Properties
Use Copy Design
Select Beam With Properties
Select All Other Beams Used For NS-1, NS-2, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
Column Properties
Use Modify Design
Select Column On NS-1
Design
Material: Steel
Description: W 8 x 48
Weight: 48.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 184.0 in4
Cross Sectional Area: 14.1 in2
Number Of Shear Studs: 0
Select From Database
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs

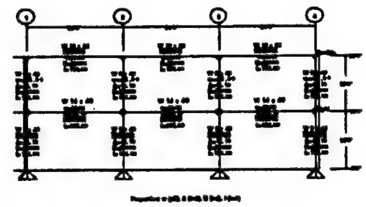

Show Structure
☐ Design Sizes
Select Second Floor/ Lower Roof Horizontal Structural Plane
Load Combination D + W
Use Load Combination
Set Factors
Dead: 1.0
Wind: 1.0
Add
OK Button To Close Dialog Window
Highlight D+W In List
Lateral Analysis
Use Lateral Resistance Design
Select NS-1
Analysis
Units: Feet & Pounds
Load Combination: D+W
☒ Use Actual Properties
☐ DL=Deck+Self Weight
Connectivity
◉ Hinge
Repeat For All Supports

Lateral Analysis

Lateral Resistance
Verify All Rigid Connections



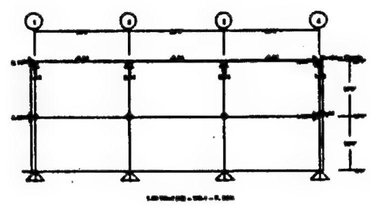
Yes, Properties Are All Correct



Wind Load Options
Wind Direction: South
When 2 Wind Loads: Max. Suction
Wind Load: GCpi = 0

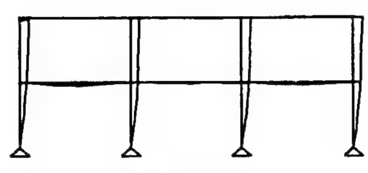
Flexible Diaphragm
◉ Simple Beam Model

Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
☐ Enter Deflections At Each Level



View Loads

Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct

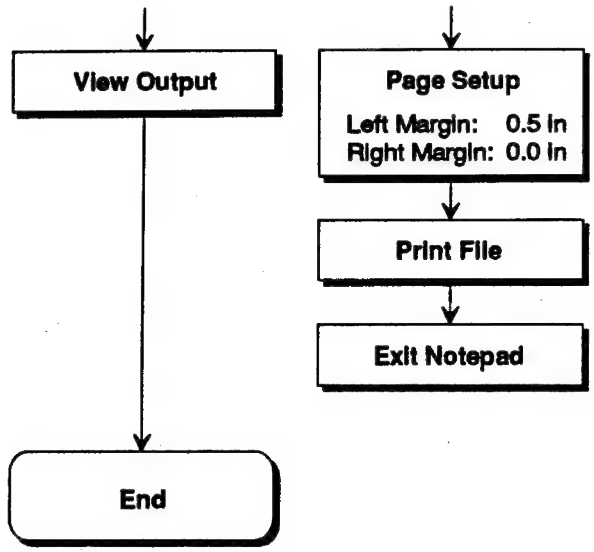


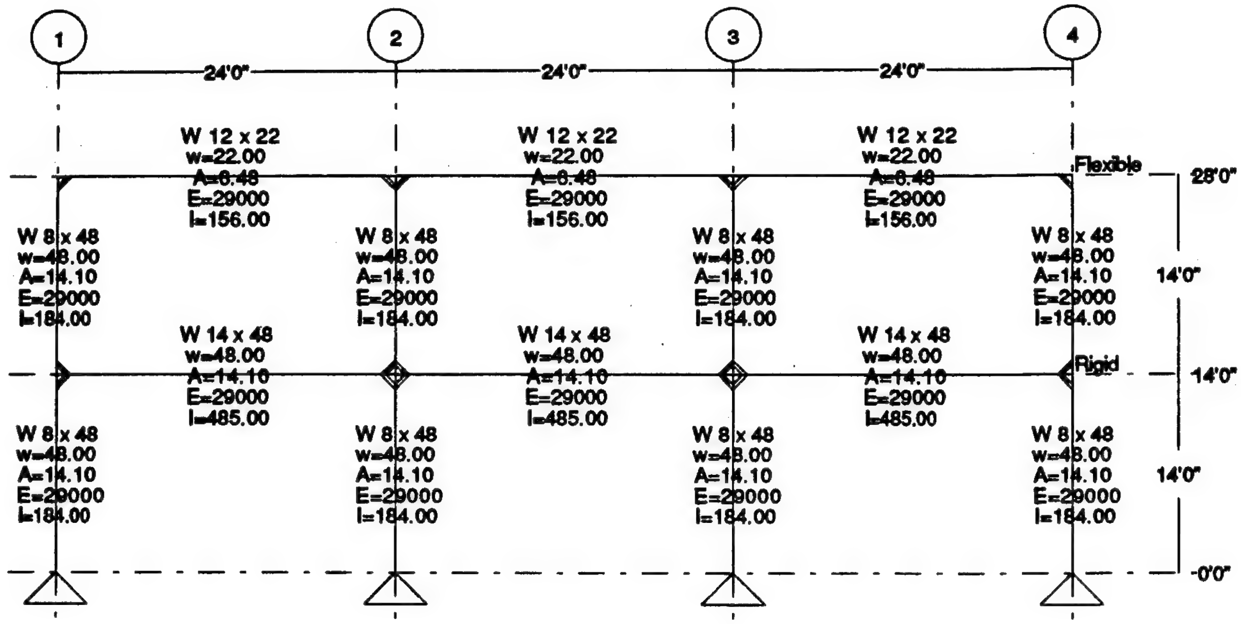
View Shear, Moment, Deflection & Reaction Diagrams

View Output

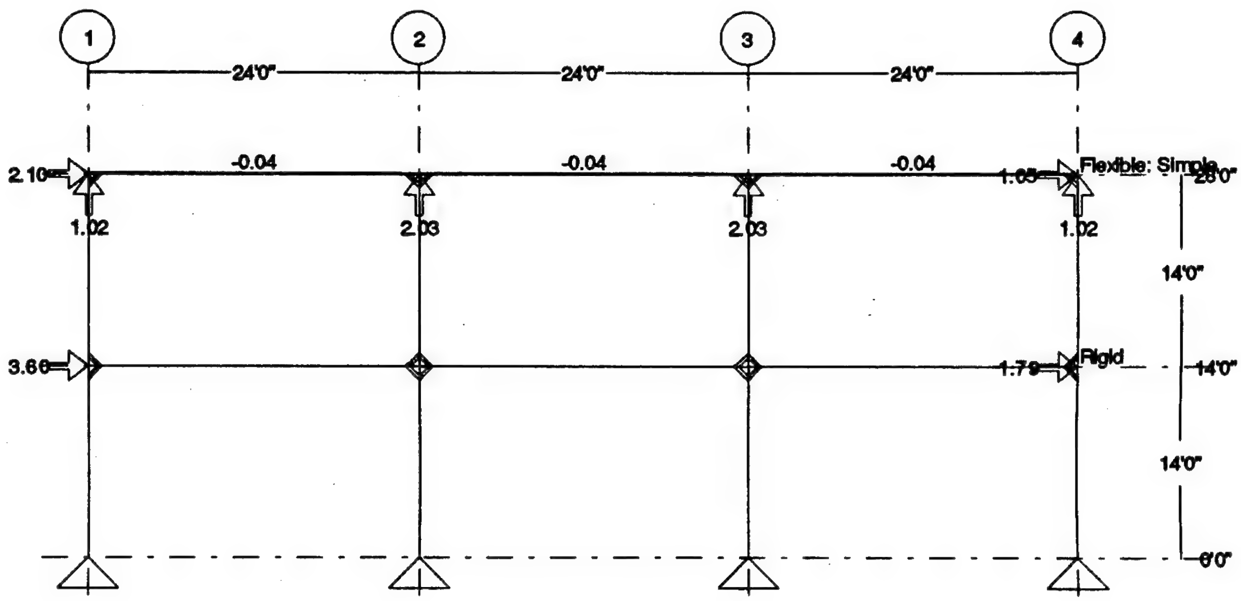
Print Data
☒ Rigid Diaphragm
☐ All Other
☒ Print To File
☒ Execute Notepad

Scroll Output

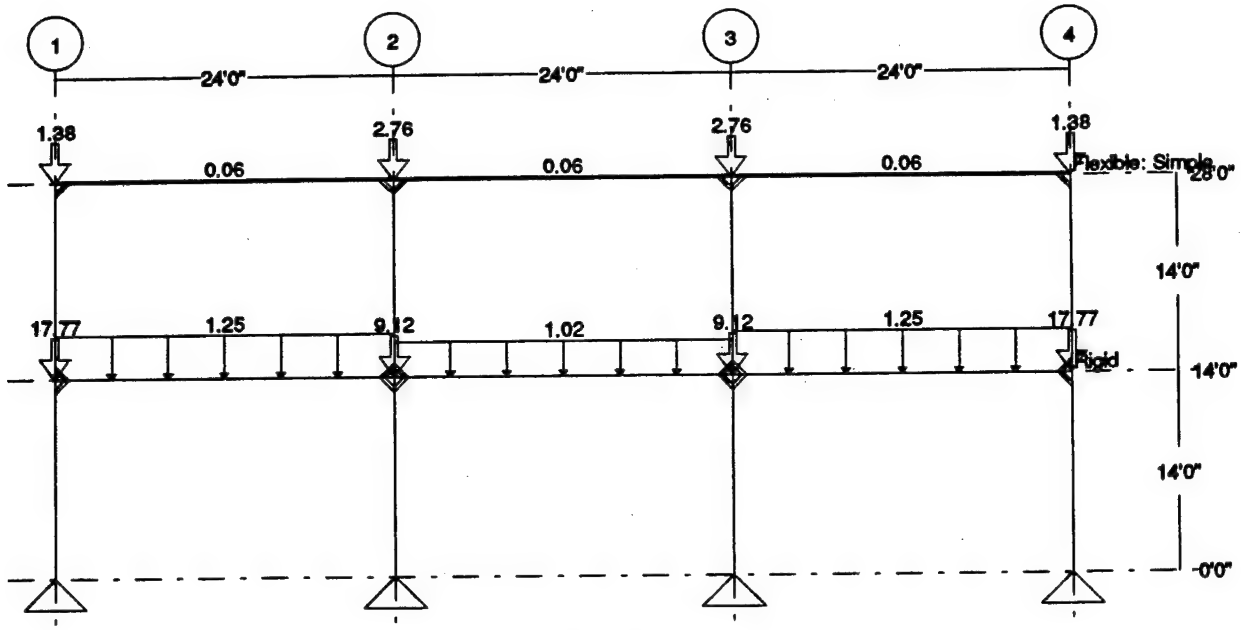

View Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End



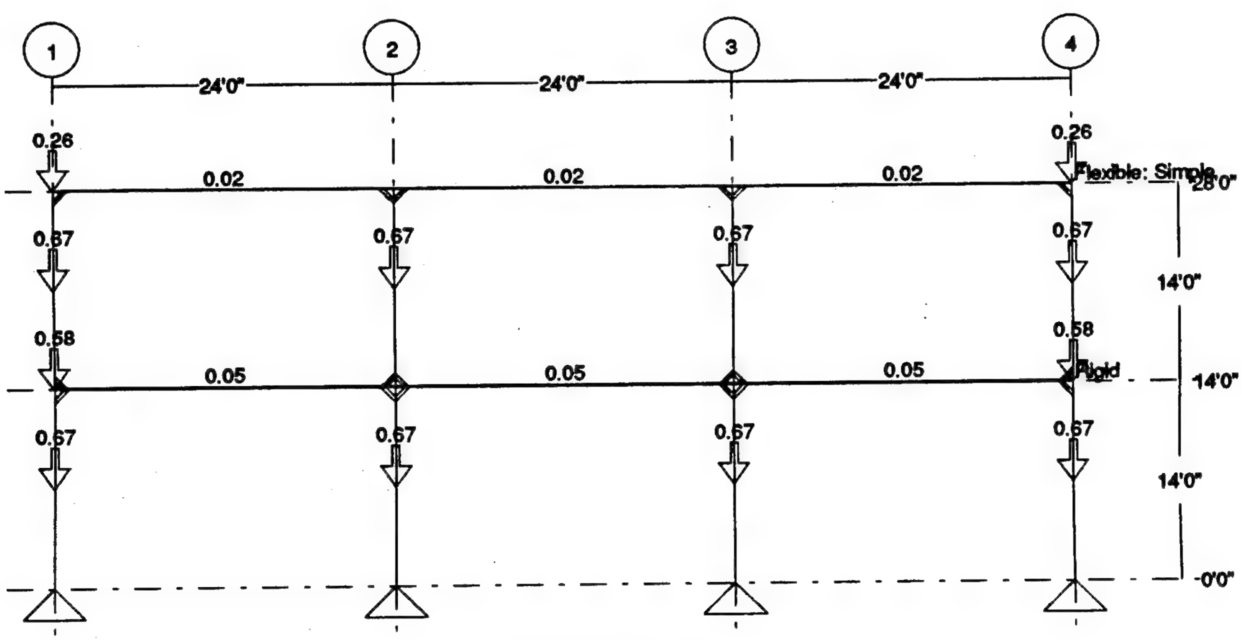
Properties: w (plf), A (in2), E (ksi), I (in4)



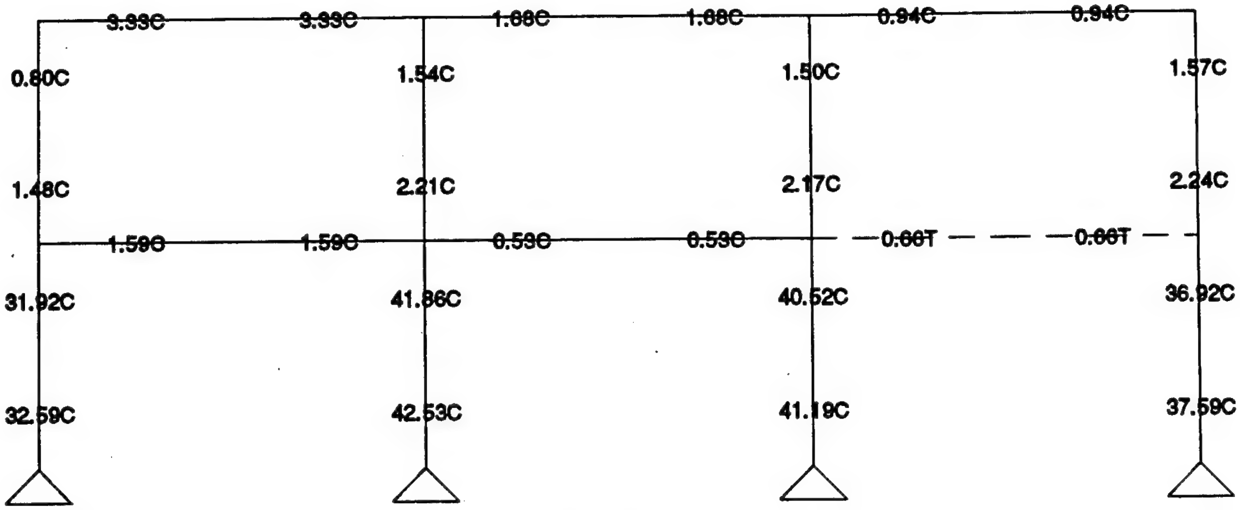
1.00 Wind (klf) – NS-1 – F, 32%



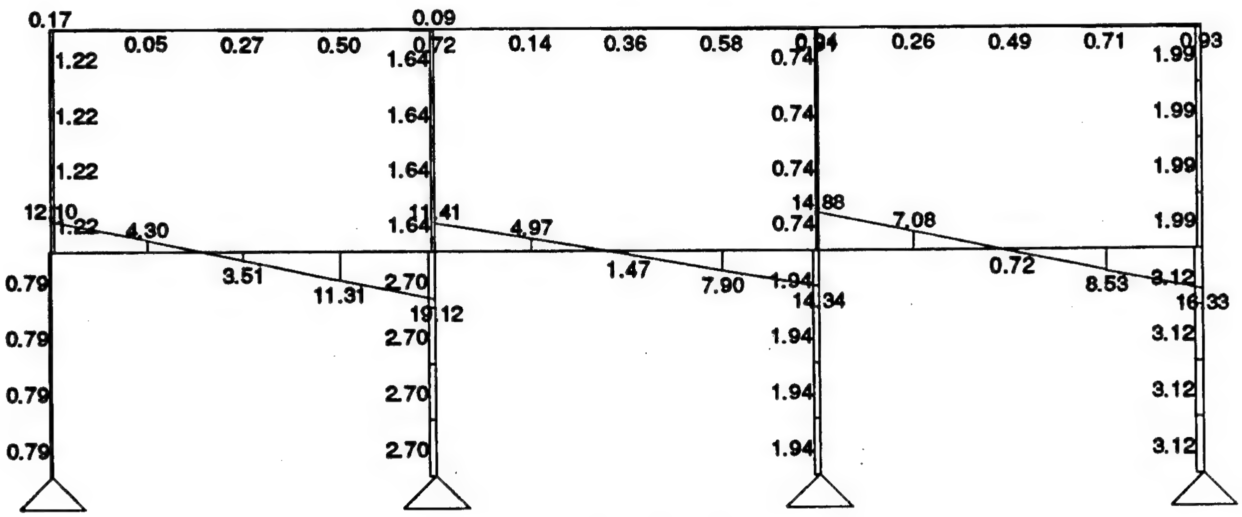
1.00 Superimposed Dead (klf) -- NS-1



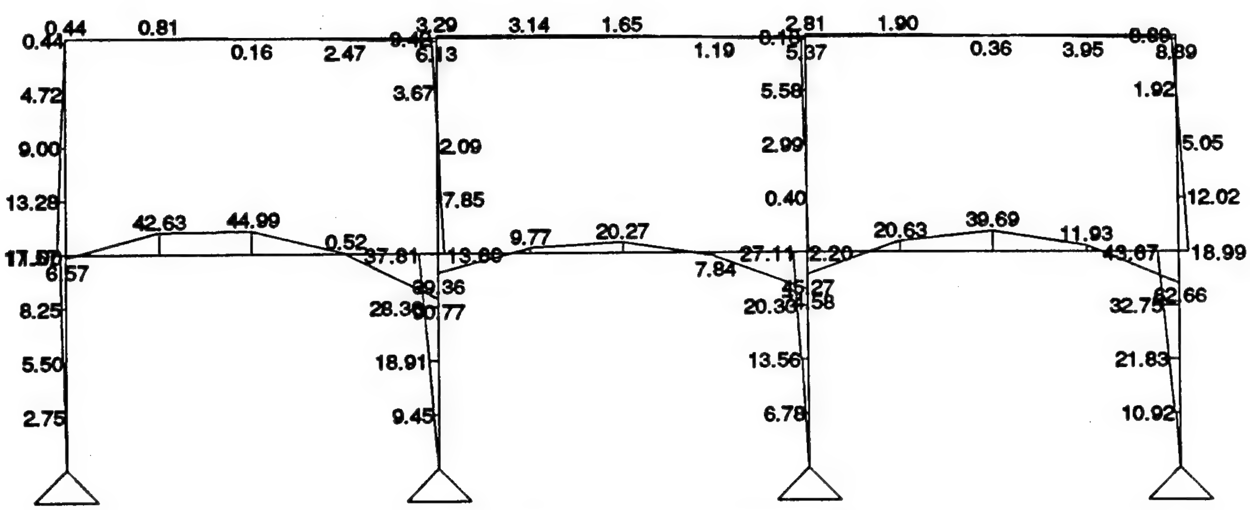
1.00 Dead (klf) -- NS-1



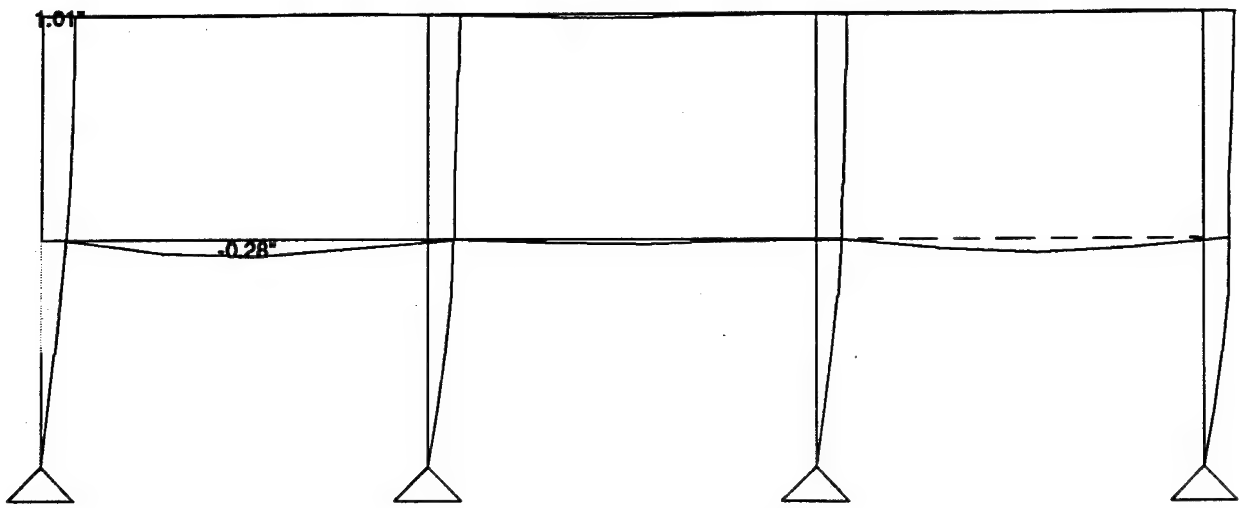
Total Combined Load: D + W -- Axial (k)



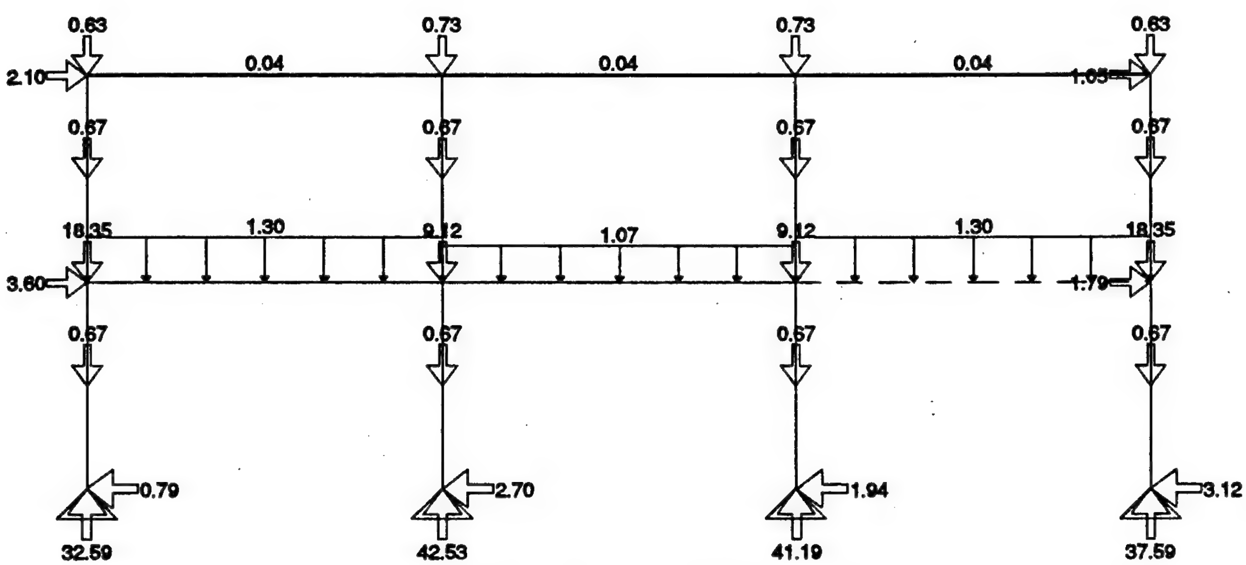
Total Combined Load: D + W -- Shear (k)



Total Combined Load: D + W – Moment (ft-k)



Total Combined Load: D + W -- Deflection



Total Combined Load: D + W – Loads & Reactions (k)

Project : Office Building - Scheme A
Location : Radford AAP
Time : Wed Aug 31, 1994 1:09 PM

***************** Rigid Horizontal Diaphragm Calculations *****************

Center of Rigidity

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
NS-1	14.0	0	0	100.834	0.010	32.48%	0.8	0.008
NS-2	14.0	0	0	100.834	0.010	32.48%	48.8	0.484
NS-3	14.0	0	0	93.487	0.011	35.04%	84.8	0.907
Sum					0.031			1.400

Centroid from lower left = sum(R*x)/sum(R) : 45.85 ft
Maximum rigid diaphragm dimension : 85.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 3.02 ft

Name	h (ft)	I (ft^4)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
EW-1	14.0	0	0	78.168	0.013	50.00%	72.8	0.932
EW-2	14.0	0	0	78.168	0.013	50.00%	0.8	0.011
Sum					0.026			0.942

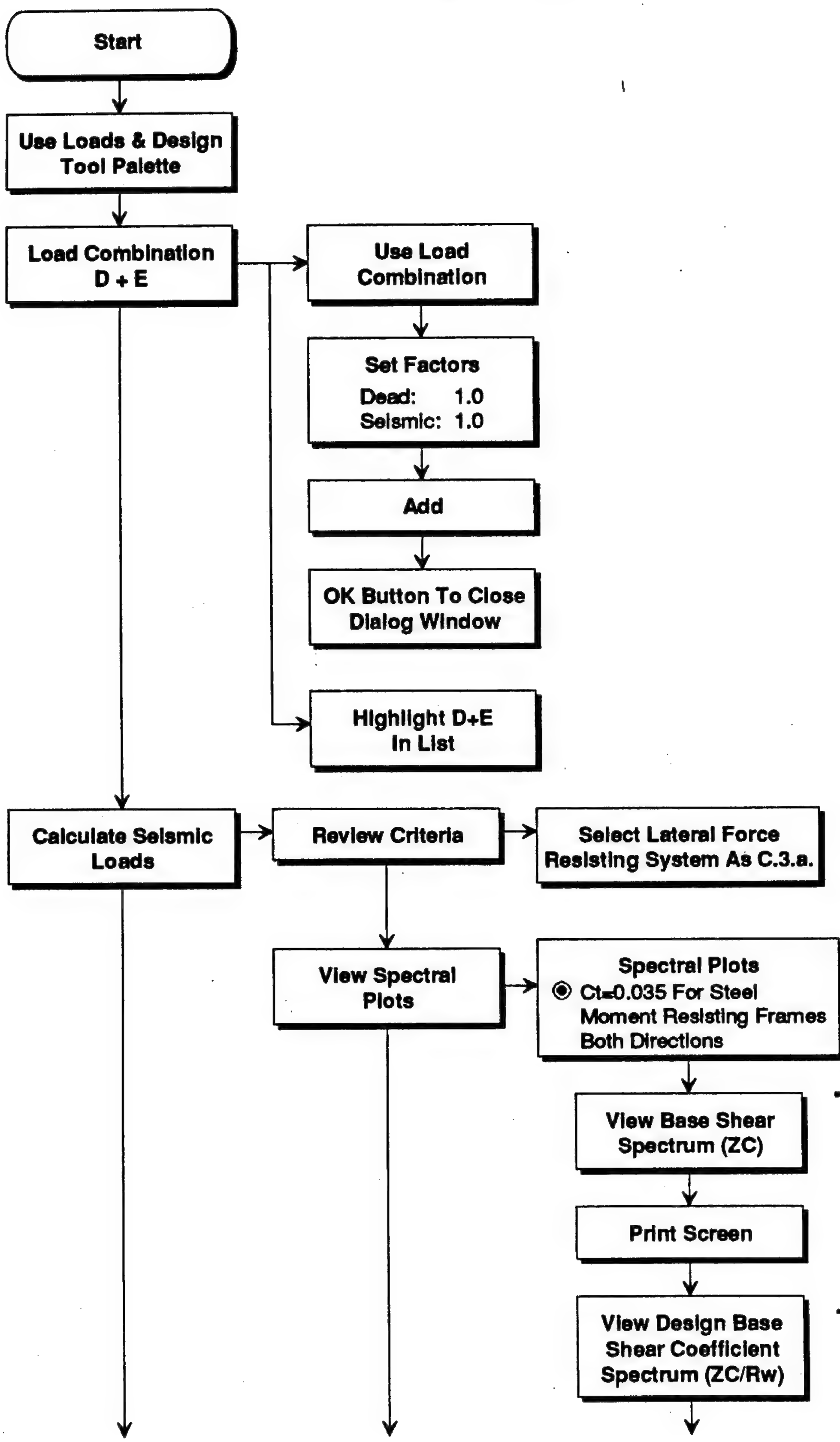
Centroid from lower left = sum(R*x)/sum(R) : 36.83 ft
Maximum rigid diaphragm dimension : 73.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 0.00 ft

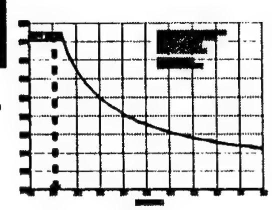
Assumptions used:
Deflections calculated by applying a 1000 k load.

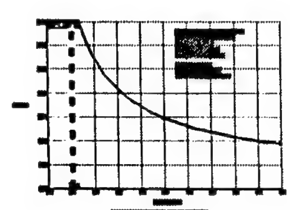
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	14.0	0.010	45.0	0.446	20.101	0.00641
NS-2	14.0	0.010	3.0	0.030	0.088	0.00042
NS-3	14.0	0.011	39.0	0.417	16.252	0.00599
EW-1	14.0	0.013	36.0	0.461	16.580	0.00662
EW-2	14.0	0.013	36.0	0.461	16.580	0.00662
Sum					69.601	

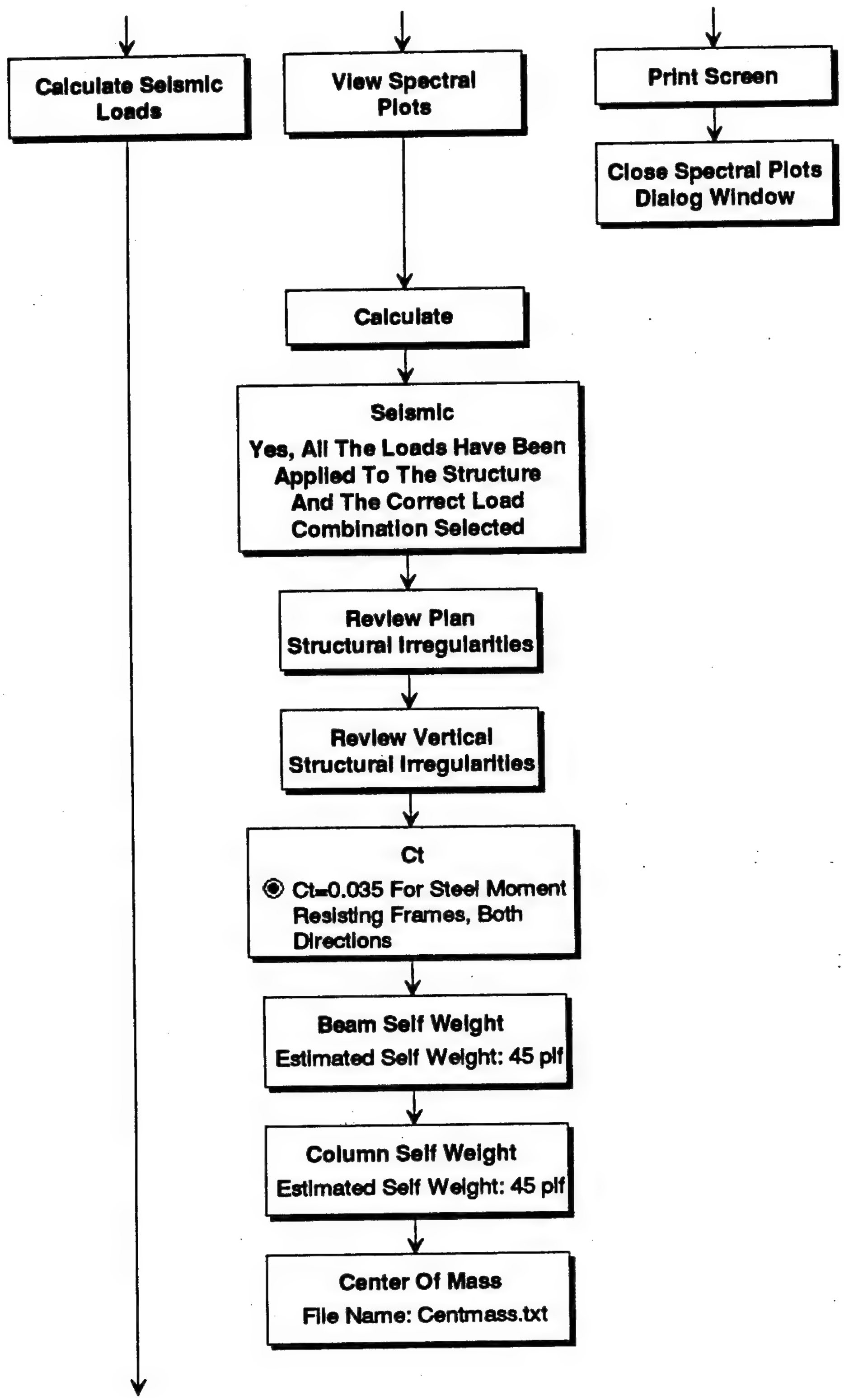
Shear distribution : Fv = V*R/sum(R)
Torsional moment : Mt = V*e
Torsional component : Ft = Mt*R*dx/sum(R*dx*dx)
Total shear to element: Ftotal = Fv + Ft

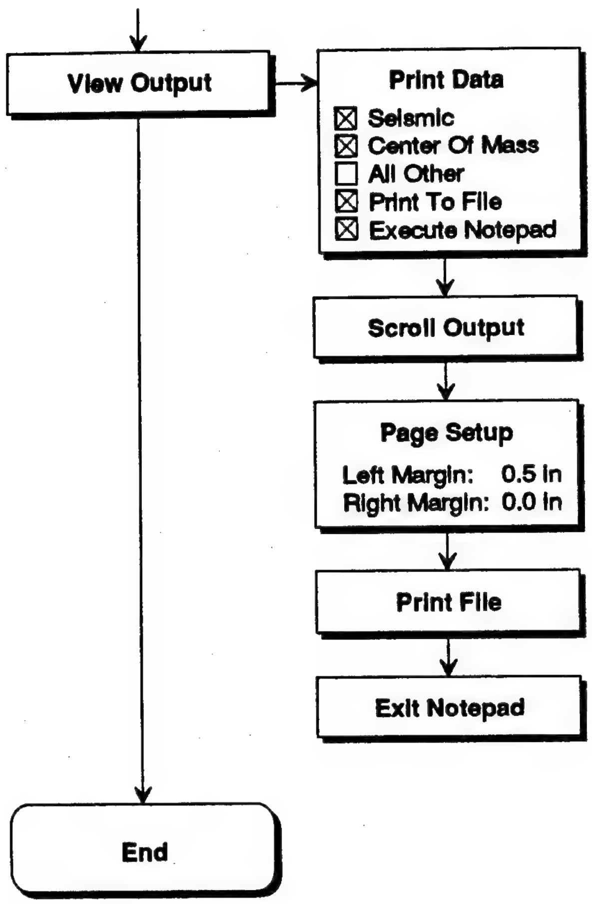
Seismic Loads

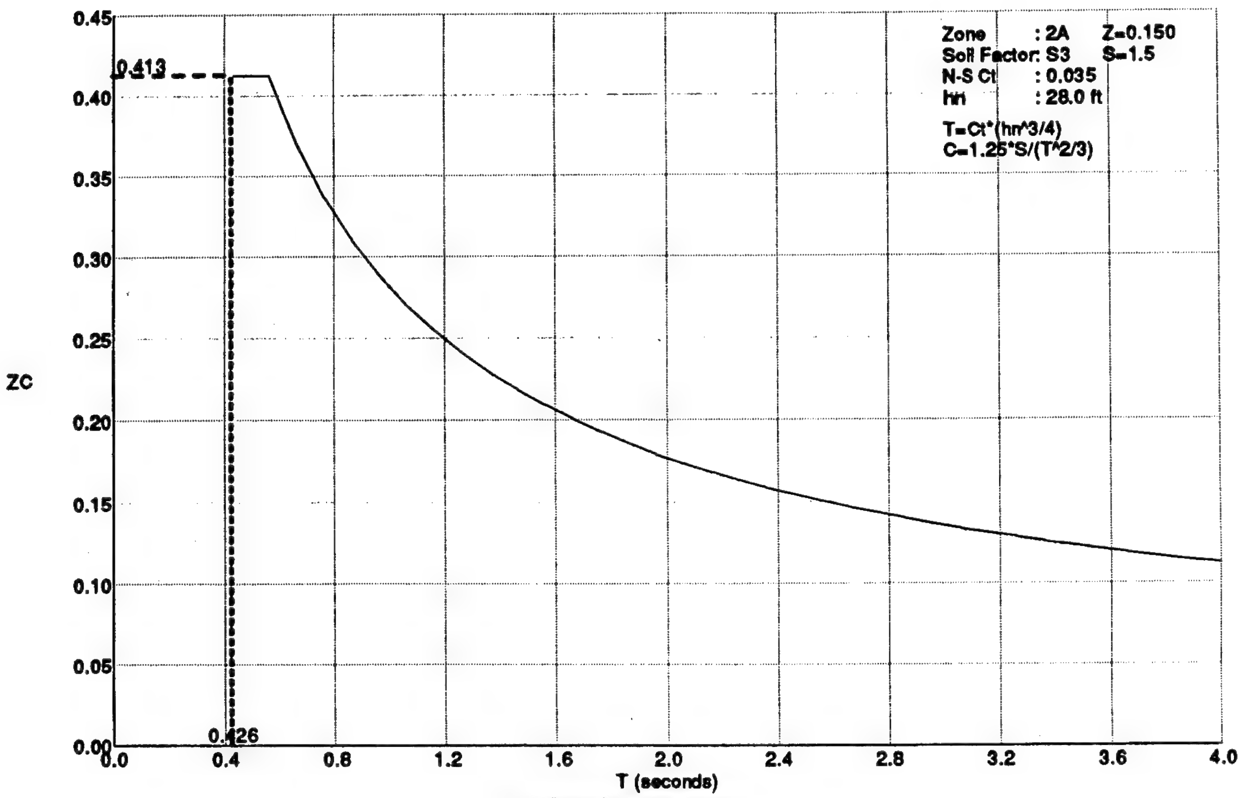




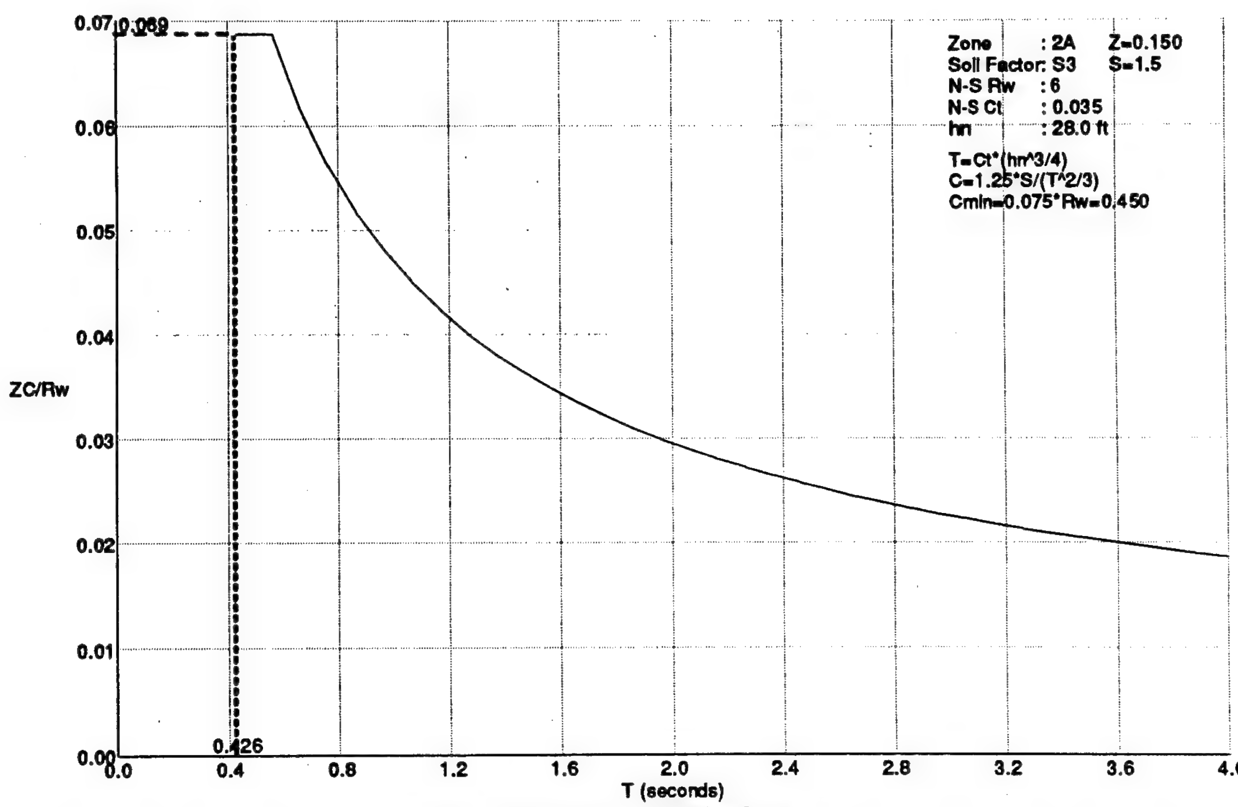



Calculate Seismic Loads
View Spectral Plots
Print Screen
Close Spectral Plots Dialog Window
Calculate
Seismic
Yes, All The Loads Have Been Applied To The Structure And The Correct Load Combination Selected
Review Plan Structural Irregularities
Review Vertical Structural Irregularities
Ct
Ct=0.035 For Steel Moment Resisting Frames, Both Directions
Beam Self Weight
Estimated Self Weight: 45 plf
Column Self Weight
Estimated Self Weight: 45 plf
Center Of Mass
File Name: Centmass.txt


View Output
Print Data
Seismic
Center Of Mass
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End



N-S Base Shear Spectrum



N-S Design Base Shear Coefficient Spectrum

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Seismic Code: TM 5-809-10 1992
Time         : Wed Aug 31, 1994  2:28 PM

**************************** Seismic Analysis *****************************

 3. Upper Roof                                    :     194.9 k
 2. Second Floor/Lower Roof                       :     686.9 k
---------------------------------------------------------
Total Building Weight (W)                         :     881.7 k

***************************** N - S and E - W *****************************

Zone: 2A: Z = 0.150
Importance Category: IV: I = 1.00
Soil Factor: S3: S = 1.5
System: C3a: Rw = 6
Ct = 0.035
hn = 28.0 ft
T = Ct*hn^3/4 = 0.426 sec
C = 1.25*S/T^2/3 = 3.31 > 2.75
C = 2.75
C/Rw = 0.458 > 0.075
W = 881.7 k
V = Z*I*C*W/Rw
+-------------------------+
|       V = 60.6 k        |
+-------------------------+

T < 0.7 sec
+-------------------------+
|       Ft = 0.0 k        |
+-------------------------+

+-------------------------+
|     V-Ft = 60.6 k       |
+-------------------------+
```

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	w*h (kft)	w*h/ sum(w*h)	F (k)	sum(F) V (k)
						Ft =	0.0	
3	28.0		195		5457	0.362	21.9	
		14.0		195				21.9
2	14.0		687		9616	0.638	38.7	
		14.0		882				60.6
1	0.0							
Sum			882		15073	1.000	60.6	

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)	Ft+sum(F)/ sum(w)
3	28.0		195					
		14.0		195	21.9	307		0.113
2	14.0		687				307	
		14.0		882	60.6	849		0.069
1	0.0						1156	
Sum			882			1156		

Project : Office Building - Scheme A
Location : Radford AAP
Time : Wed Aug 31, 1994 2:28 PM

****************************** Center Of Mass ******************************

Upper Roof -- 28.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Exterior Wall	36.9	36.8	1358.9	0.8	30.7
Exterior Wall	24.6	0.8	20.5	24.8	610.8
Exterior Wall	36.9	36.8	1358.9	48.8	1801.6
Exterior Wall	24.6	72.8	1791.4	24.8	610.8
Upper Roof	49.8	36.8	1833.1	24.8	1235.9
Beam Self Weight	18.4	36.8	676.3	24.8	455.9
Column Self Weight	3.8	36.8	139.2	24.8	93.9
Sum	194.9		7178.2		4839.6

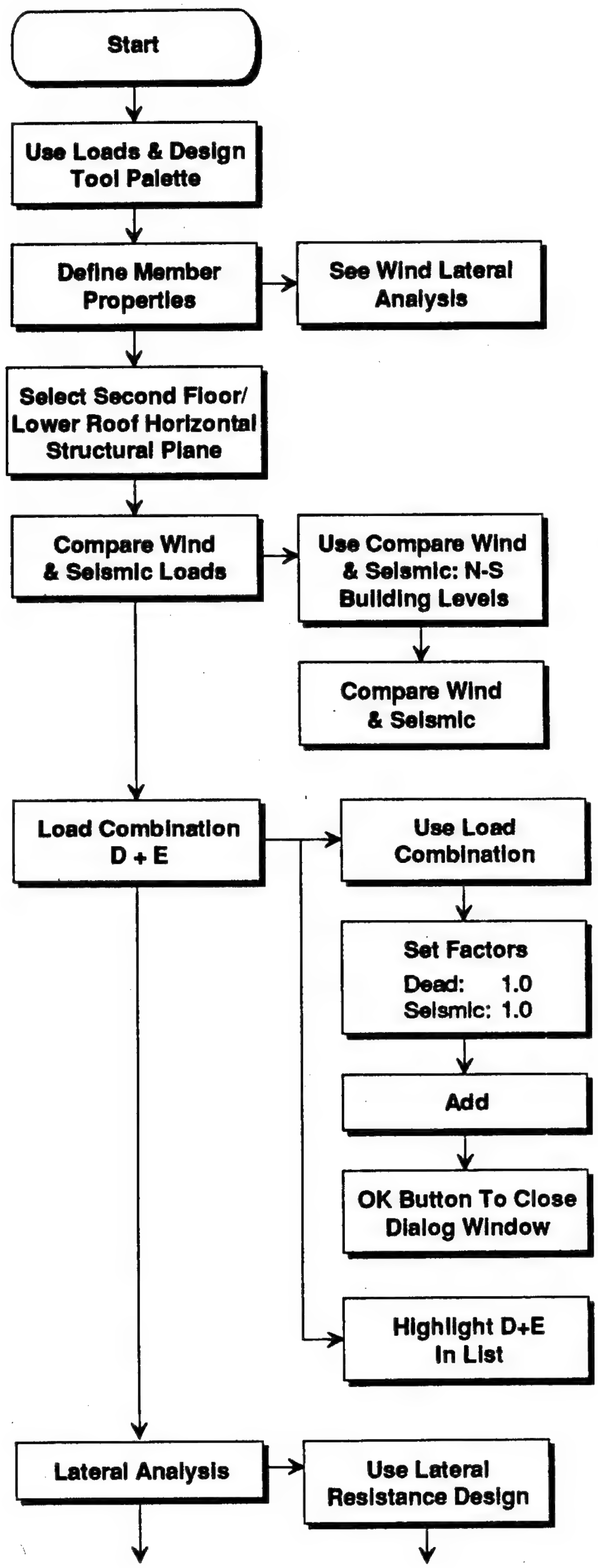
N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 24.83 ft

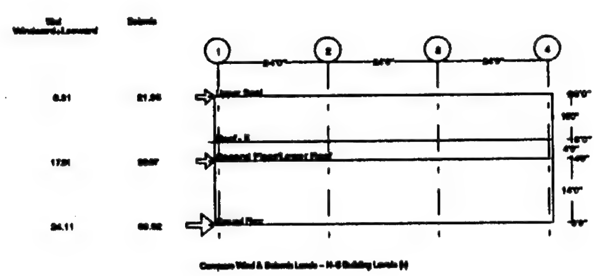
Second Floor/Lower Roof -- 14.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Second Floor	72.9	12.8	935.1	24.8	1809.5
Second Floor	60.7	36.8	2236.5	28.8	1750.8
Second Floor	72.9	60.8	4432.6	24.8	1809.5
Lower Roof	123.6	36.8	4554.0	66.8	8263.2
Exterior Wall	73.8	36.8	2717.8	0.8	61.5
Exterior Wall	24.6	0.8	20.5	24.8	610.8
Exterior Wall	36.9	36.8	1358.9	48.8	1801.6
Exterior Wall	24.6	72.8	1791.4	24.8	610.8
Parapet	9.9	0.8	8.3	66.8	662.1
Parapet	19.8	36.8	729.8	84.8	1680.9
Parapet	9.9	72.8	721.6	66.8	662.1
Beam Self Weight	24.8	36.8	914.9	36.2	899.9
Column Self Weight	5.7	36.8	208.8	36.2	205.4
Exterior Wall	43.0	0.8	35.9	42.8	1843.6
Exterior Wall	36.9	36.8	1358.9	84.8	3129.7
Exterior Wall	43.0	72.8	3134.9	42.8	1843.6
Column Self Weight	3.8	36.8	139.2	24.8	93.9
Sum	686.9		25299.0		27738.8

N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 40.39 ft

Seismic Lateral Analysis





Lateral Analysis

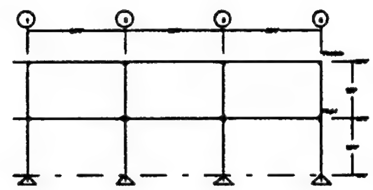
Select NS-1

Analysis
Units: Feet & Kips
Load Combination: D+E
☒ Use Actual Properties
☐ DL=Deck+Self Weight

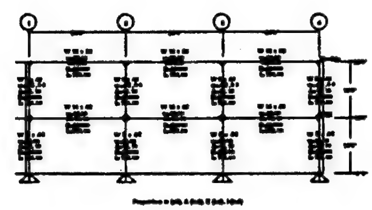
Connectivity
◉ Hinge

Repeat For All Supports

Lateral Resistance Verify All Rigid Connections

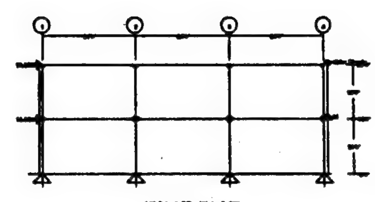


Yes, Properties Are All Correct



Flexible Diaphragm
◉ Simple Beam Model

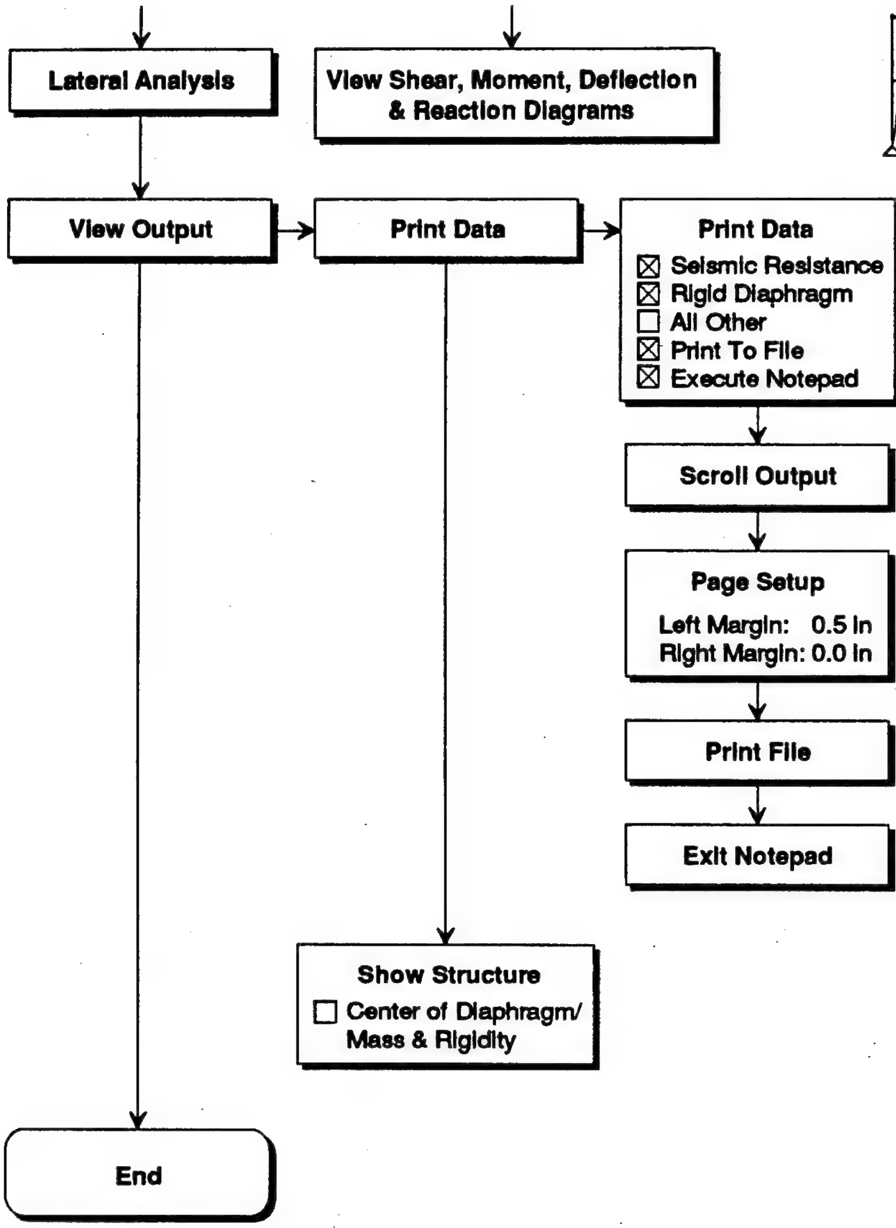
Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
☐ Enter Deflections At Each Level

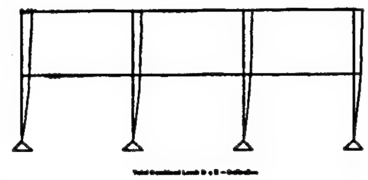


View Loads

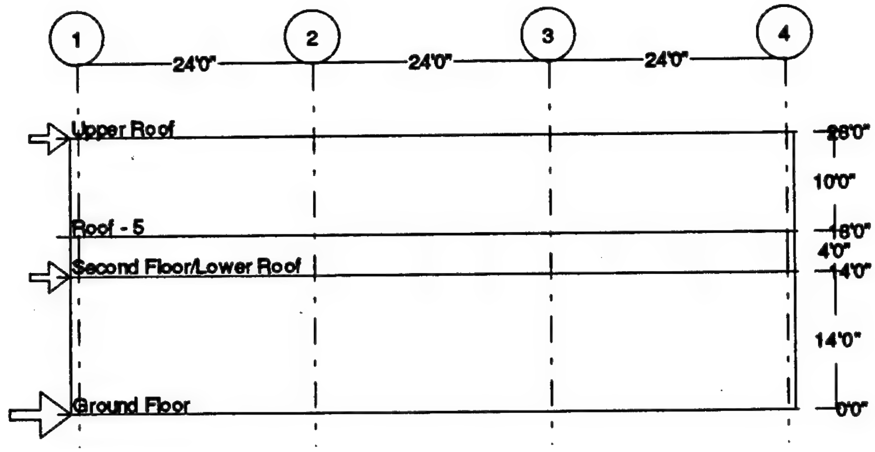
Seismic Lateral Resistance Locations
File Name: Latseis.txt

Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct

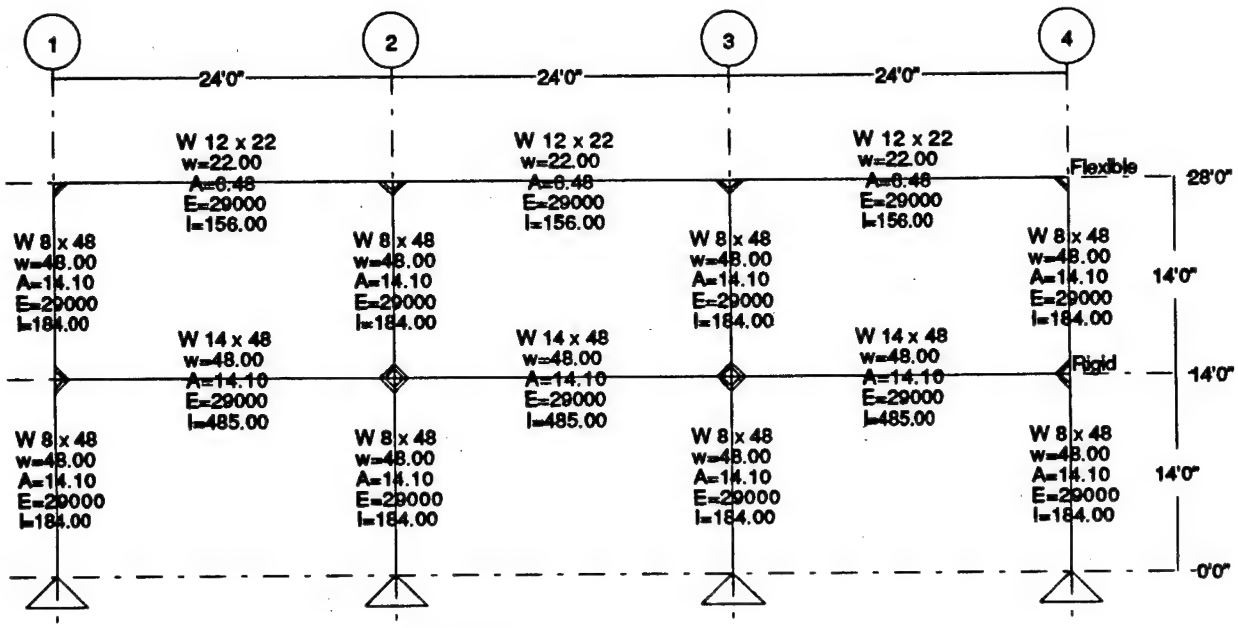

Lateral Analysis
View Shear, Moment, Deflection & Reaction Diagrams
View Output
Print Data
Print Data
☒ Seismic Resistance
☒ Rigid Diaphragm
☐ All Other
☒ Print To File
☒ Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
Show Structure
☐ Center of Diaphragm/ Mass & Rigidity
End



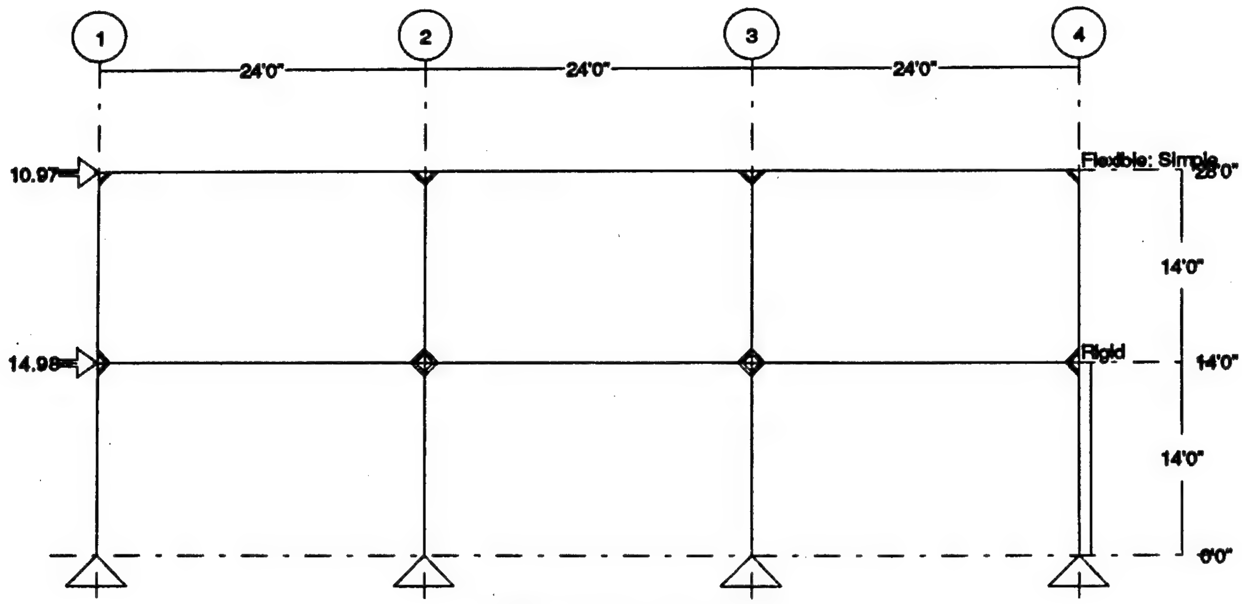
Wind Windward+Leeward	Seismic
6.31	21.95
17.81	38.67
24.11	60.62



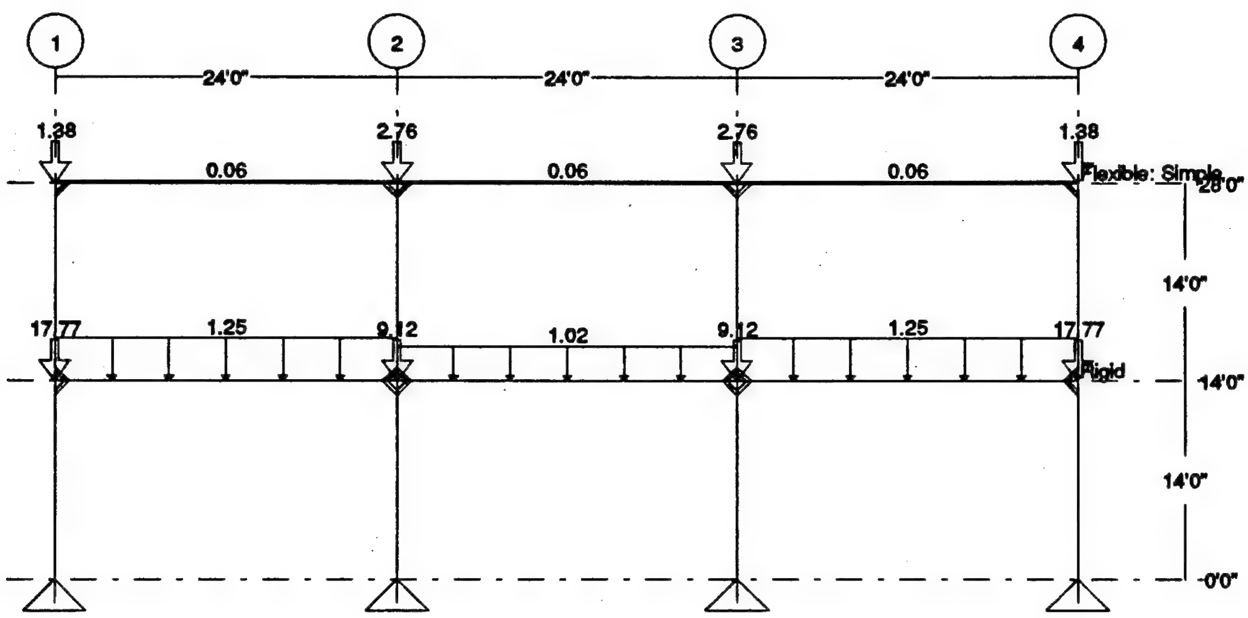
Compare Wind & Seismic Loads -- N-S Building Levels (k)



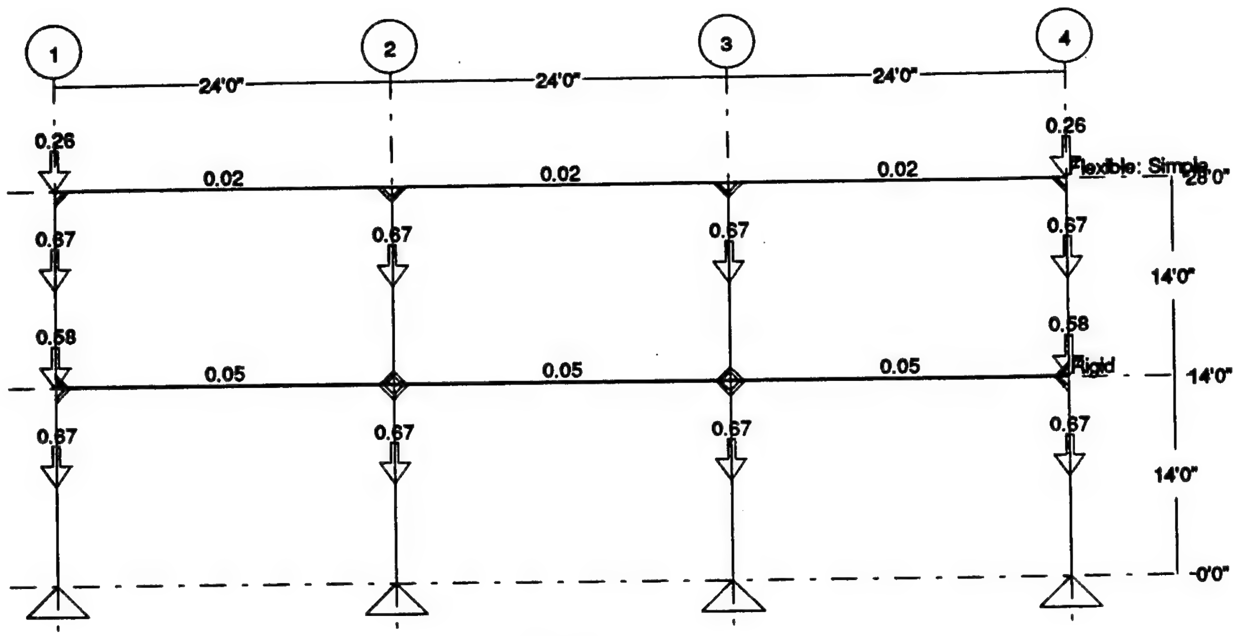
Properties: w (plf), A (in2), E (ksi), I (in4)



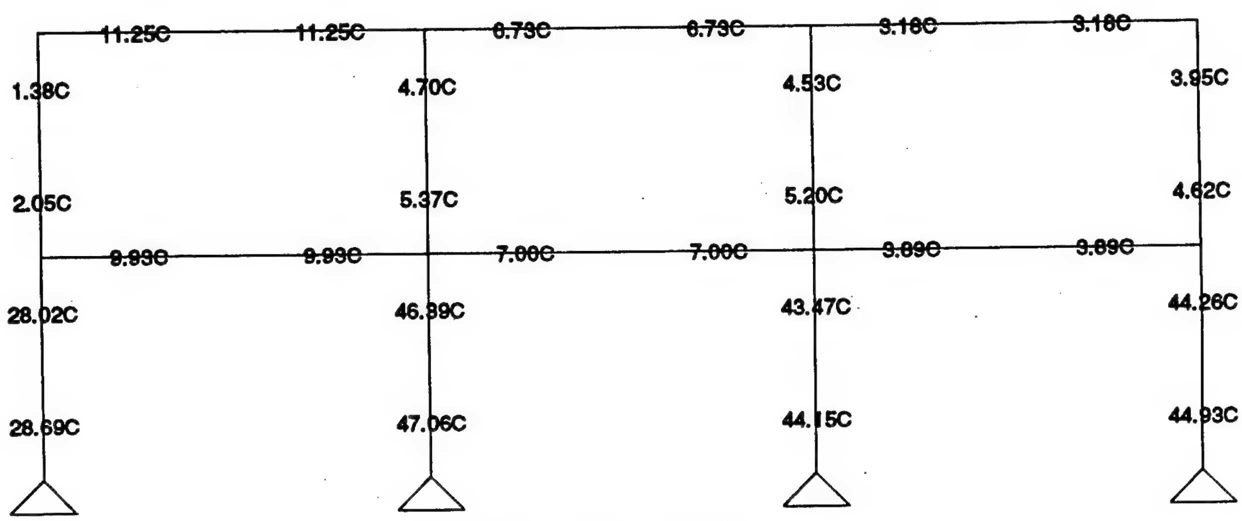
1.00 Seismic (klf) – NS-1 – F, 32%



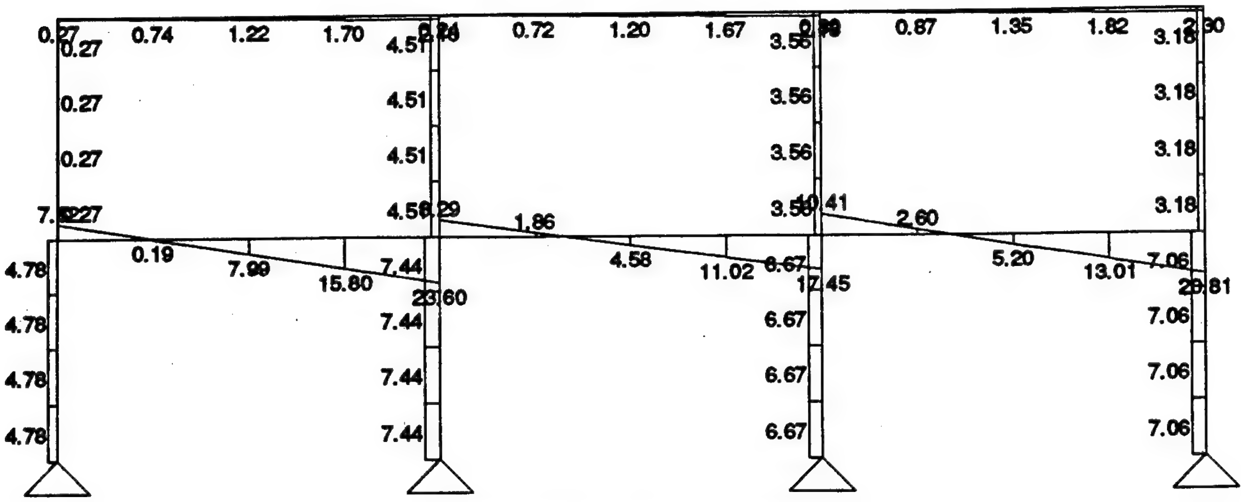
1.00 Superimposed Dead (klf) – NS-1



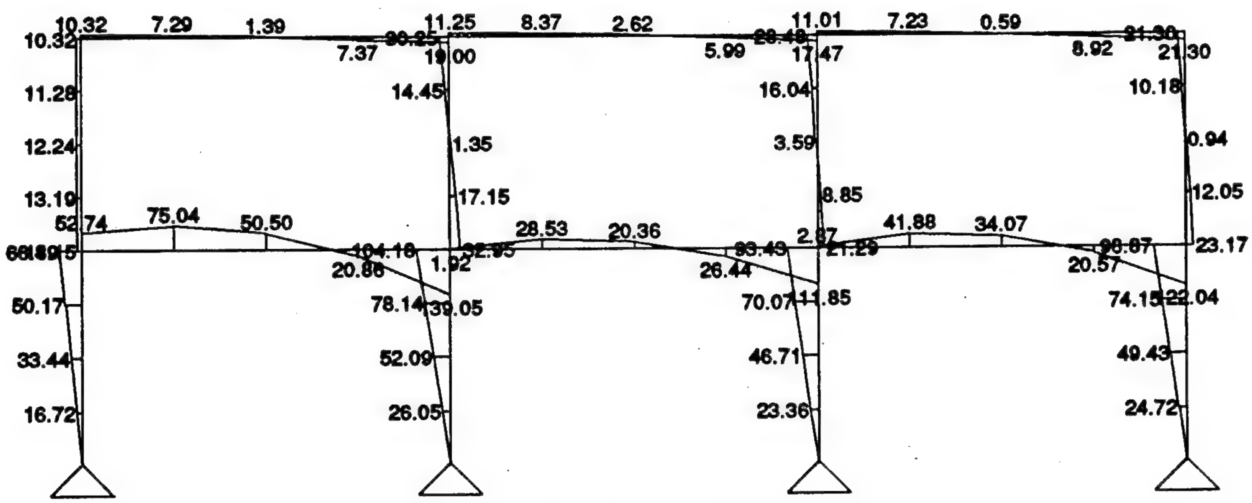
1.00 Dead (klf) -- NS-1



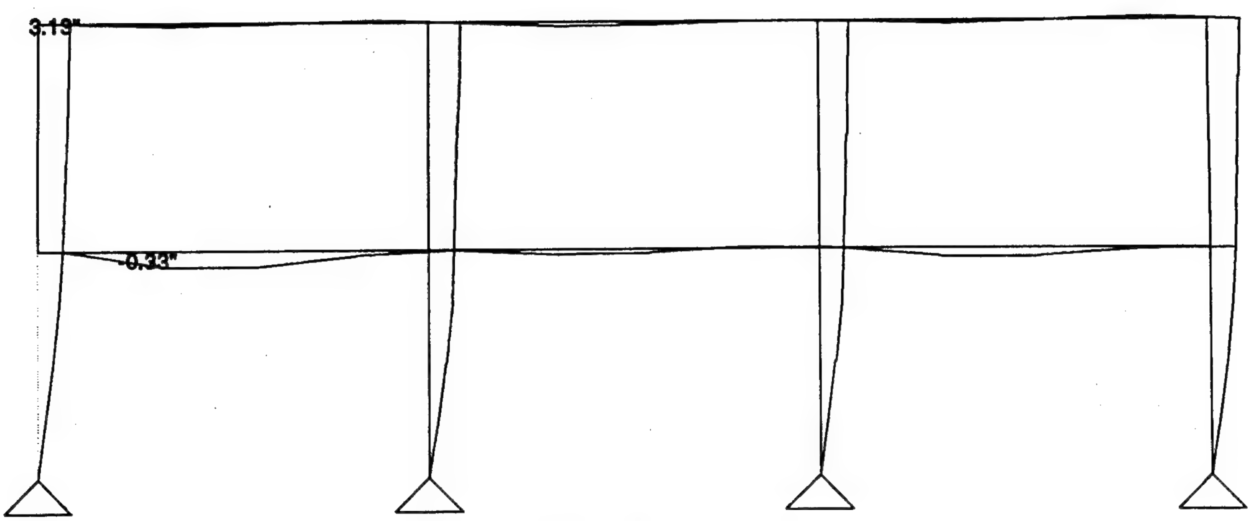
Total Combined Load: D + E -- Axial (k)



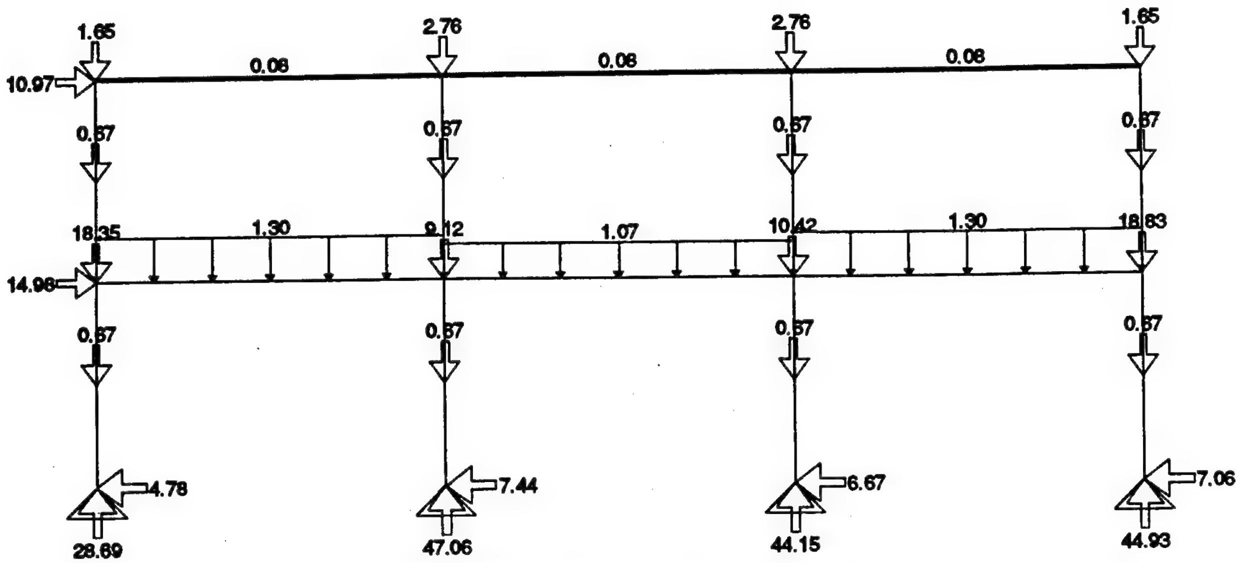
Total Combined Load: D + E – Shear (k)



Total Combined Load: D + E – Moment (ft-k)



Total Combined Load: D + E -- Deflection



Total Combined Load: D + E -- Loads & Reactions (k)

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Seismic Code: TM 5-809-10 1991
Time         : Sun Jan 26, 1992  1:43 PM
```

****************** Seismic Lateral Resistance Locations *******************

NS-1 -- F, 32%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		21.9			
		14.0		21.9	307	
2	14.0		38.7			307
		14.0		60.6	849	
1	0.0					1156
Sum			60.6		1156	

NS-2 -- F, 32%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		21.9			
		14.0		21.9	307	
2	14.0		38.7			307
		14.0		60.6	849	
1	0.0					1156
Sum			60.6		1156	

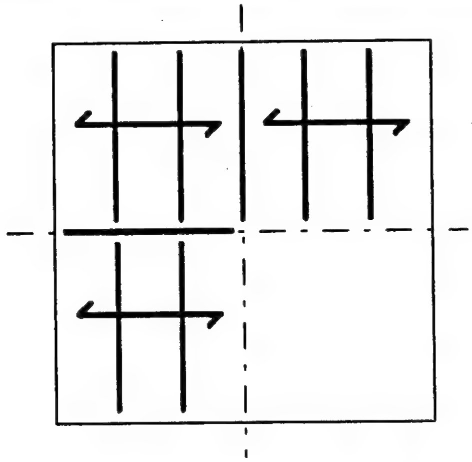
NS-3 -- F, 35%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
2	14.0		38.7			
		14.0		38.7	541	
1	0.0					541
Sum			38.7		541	

Quantity Take-Off Philosophy

3 Considerations

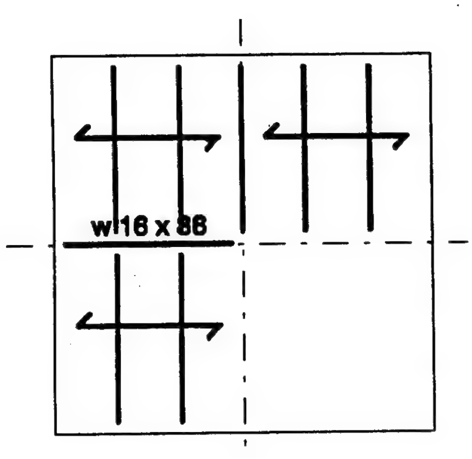
1. One typical interior bay (exterior side bay, corner bay)



2 bays
by
2 bays

2. One typical floor level and roof level

3. The entire building structural system



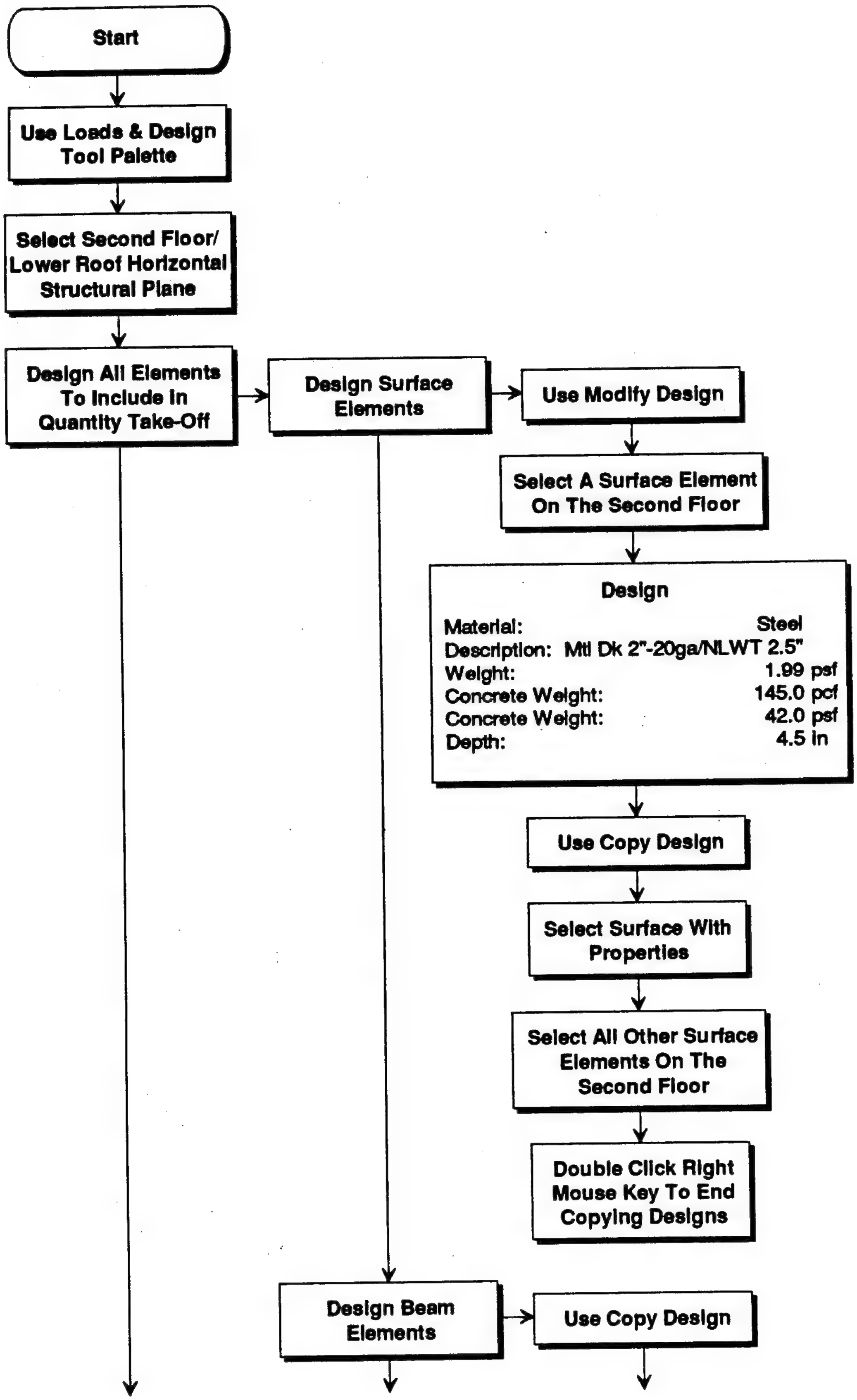
Estimated weights are not used for quantity take-offs

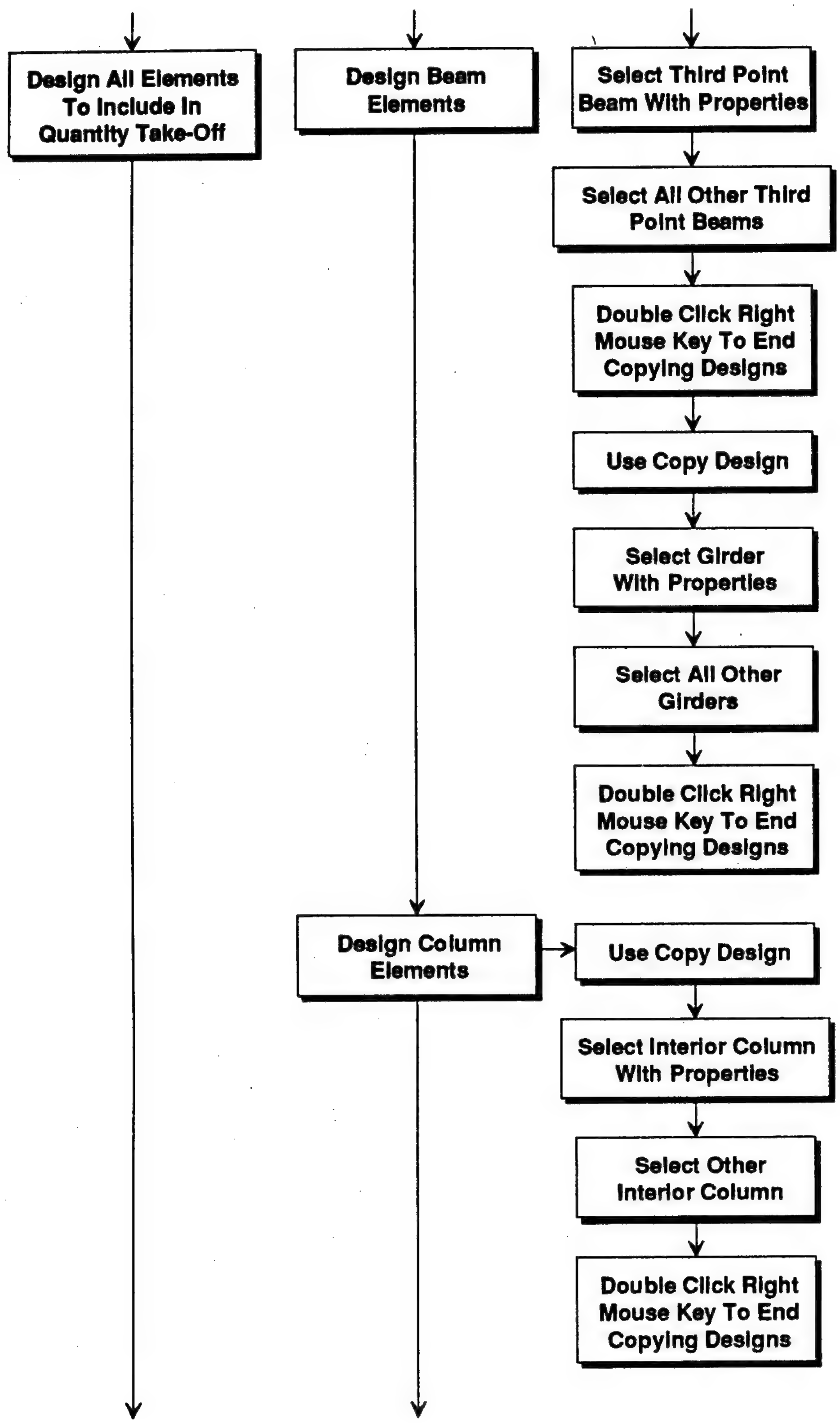
Elements designed by Excel spreadsheets are used

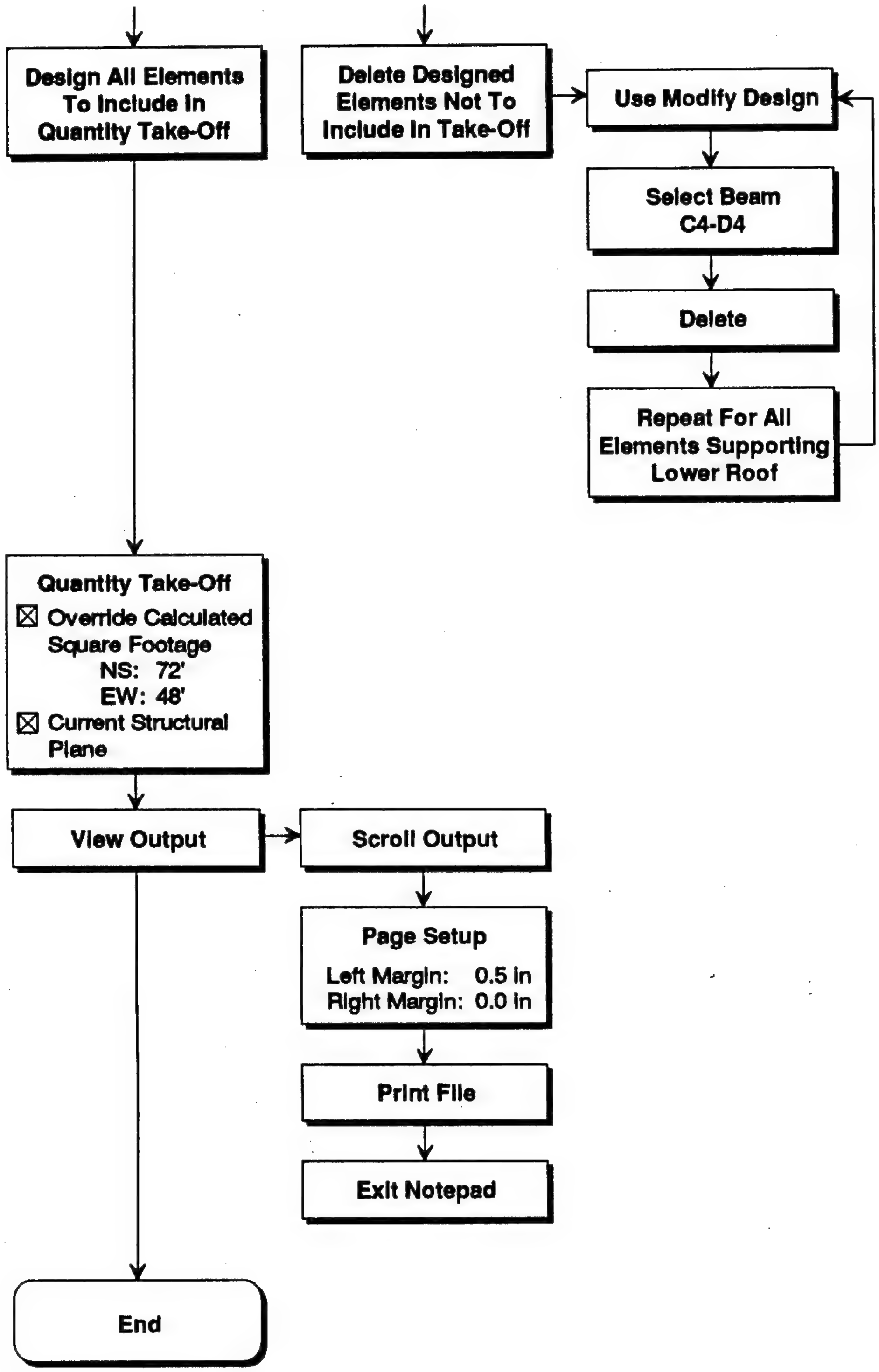
Use Modify Design and Copy Design to manually enter element sizes

Calculated square footage can be overridden

Quantity Take-Off




Design All Elements To Include In Quantity Take-Off
Design Beam Elements
Select Third Point Beam With Properties
Select All Other Third Point Beams
Double Click Right Mouse Key To End Copying Designs
Use Copy Design
Select Girder With Properties
Select All Other Girders
Double Click Right Mouse Key To End Copying Designs
Design Column Elements
Use Copy Design
Select Interior Column With Properties
Select Other Interior Column
Double Click Right Mouse Key To End Copying Designs


Design All Elements To Include In Quantity Take-Off
Delete Designed Elements Not To Include In Take-Off
Use Modify Design
Select Beam C4-D4
Delete
Repeat For All Elements Supporting Lower Roof
Quantity Take-Off
☒ Override Calculated Square Footage
NS: 72'
EW: 48'
☒ Current Structural Plane
View Output
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Project : Office Building - Scheme A
Location : Radford AAP
Time : Sun Jan 26, 1992 1:57 PM

***************************** Quantity Take-off ****************************

Second Floor/Lower Roof

Plan Area: 72.0 ft x 48.0 ft: 3456.0 sqft

STEEL: Narrowly Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
	24.0	0.0	0.0	24	0
Sum					0

Total Weight : 0.0 tons
Weight Per Square Foot : 0.0 psf

STEEL: Widely Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 14 x 48	24.0	48.0	1152.0	10	11520
	18.0	0.0	0.0	4	0
W 21 x 68	24.0	68.0	1632.0	4	6528
W 16 x 40	24.0	40.0	960.0	15	14400
	24.0	0.0	0.0	3	0
Sum					32448

Total Weight : 16.2 tons
Weight Per Square Foot : 9.4 psf

STEEL: Surface Elements

Description	Total Depth (in)	Area (sqft)	Weight (psf)	Conc Weight (pcf)	Conc Weight (psf)	Total (lbs)	Weight Conc (lbs)
Mtl Dk 2"-20ga/NLWT 2.5"	4.5	2880	2.0	145.0	42.0	5731	120960
Mtl Dk 2"-20ga/NLWT 2.5"	4.5	384	2.0	145.0	42.0	764	16128
	0.0	2592	0.0	0.0	0.0	0	0
Sum						6495	137088

Concrete Cubic Yards : 35.0
Total Weight : 3.2 tons

STEEL: Column Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 8 x 48	14.0	48.0	672.0	10	6720
W 8 x 28	14.0	28.0	392.0	2	784
	14.0	0.0	0.0	6	0
Sum					7504

Total Weight : 3.8 tons
Weight Per Square Foot : 2.2 psf

Concluding Remarks

Schemes A, B and C were developed to permit exploration and instruction of the broadest possible range of CASM capabilities. The schemes should not be viewed as completely logical structural framing solutions to the given design parameters, nor as necessarily economical. Each of the three schemes contain a variety of elements, which if properly combined and interchanged might produce "real" schemes for consideration at a 35% review.

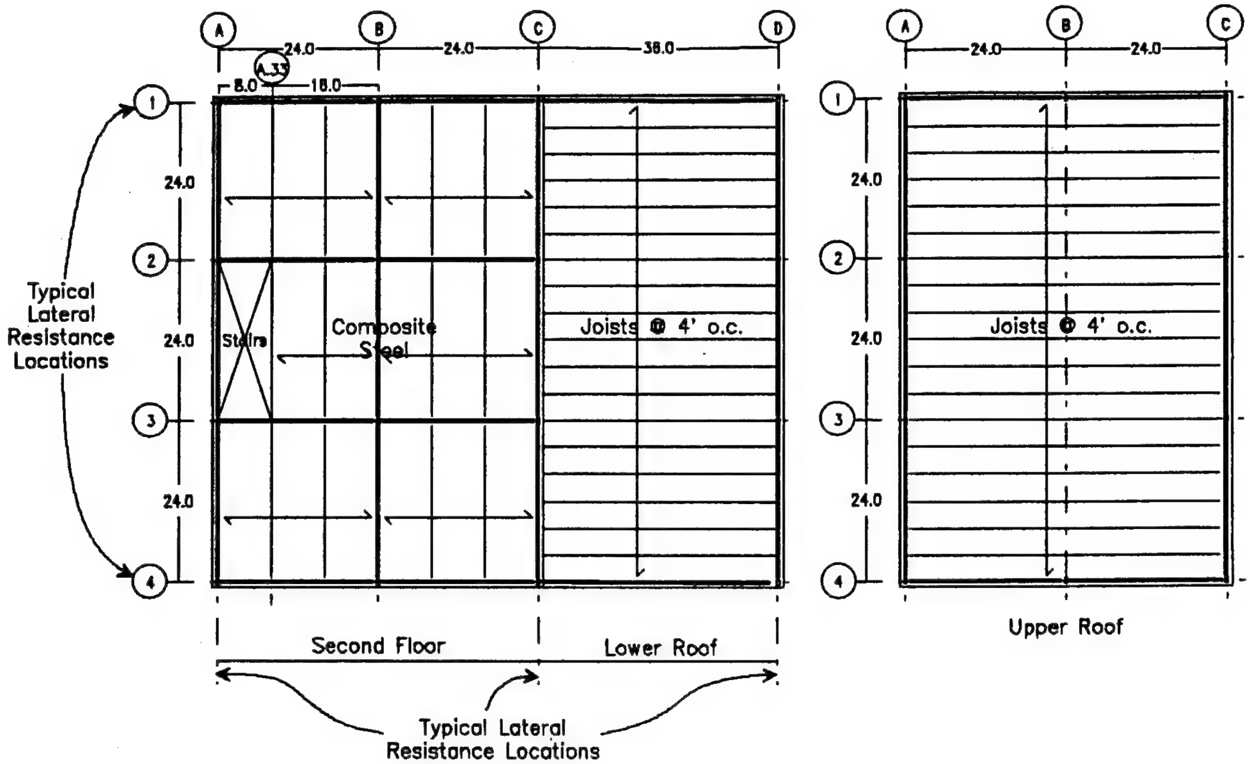
Examples of unlikely components assembled in schemes A, B and C include: (1) concrete as a decking for the low roof, (2) custom made trusses for the low roof framing, (3) prefabricated limestone wall panels mixed with cast-in-place concrete shear walls, and (4) non-composite steel beam framing for the second floor.

A logical **steel framed beam/column** solution for "real" consideration would include open web steel joists spanning 48 feet for the upper roof to eliminate a central column in the second floor space. The lower roof would be framed with 36 foot span open web steel joists (without inclusion of custom trusses) as in scheme B. Both roofs would be sheathed with a metal roof deck without concrete and both would become flexible diaphragms. The second floor would be framed with composite steel beams as in scheme B and remain a rigid diaphragm. Two lateral load resistance system options could be compared. One scheme could include a moment resistant frame approach similar to scheme A, while a second approach might incorporate trussing similar to scheme B. The non-loadbearing exterior envelope is open to a variety of possibilities. The Architects will likely dictate the aesthetic expression. The foundation system would be a combination of isolated and linear spread footings.

A third logical solution would be a **masonry bearing wall** system to support the steel open-web joist roof planes described above. The second floor plane might be constructed of pre-cast pre-stressed hollow cored planks, which would also bear on the walls and a central steel girder line. Some of these walls could become shear walls for lateral load resistance. Thus the exterior envelope and the interior partition provide a structural function, eliminating costly moment connections and columns within the exterior wall layout. Footings are now all linear spread footings with only one isolated footing.

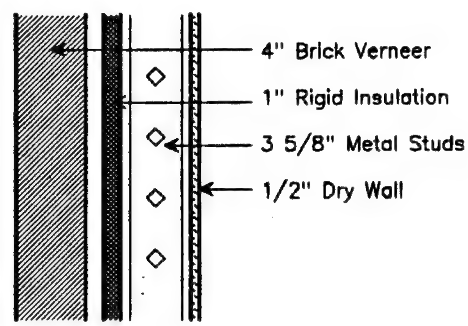
It is unlikely that a reinforced concrete frame would present an economical solution for a 1-2 story office building.

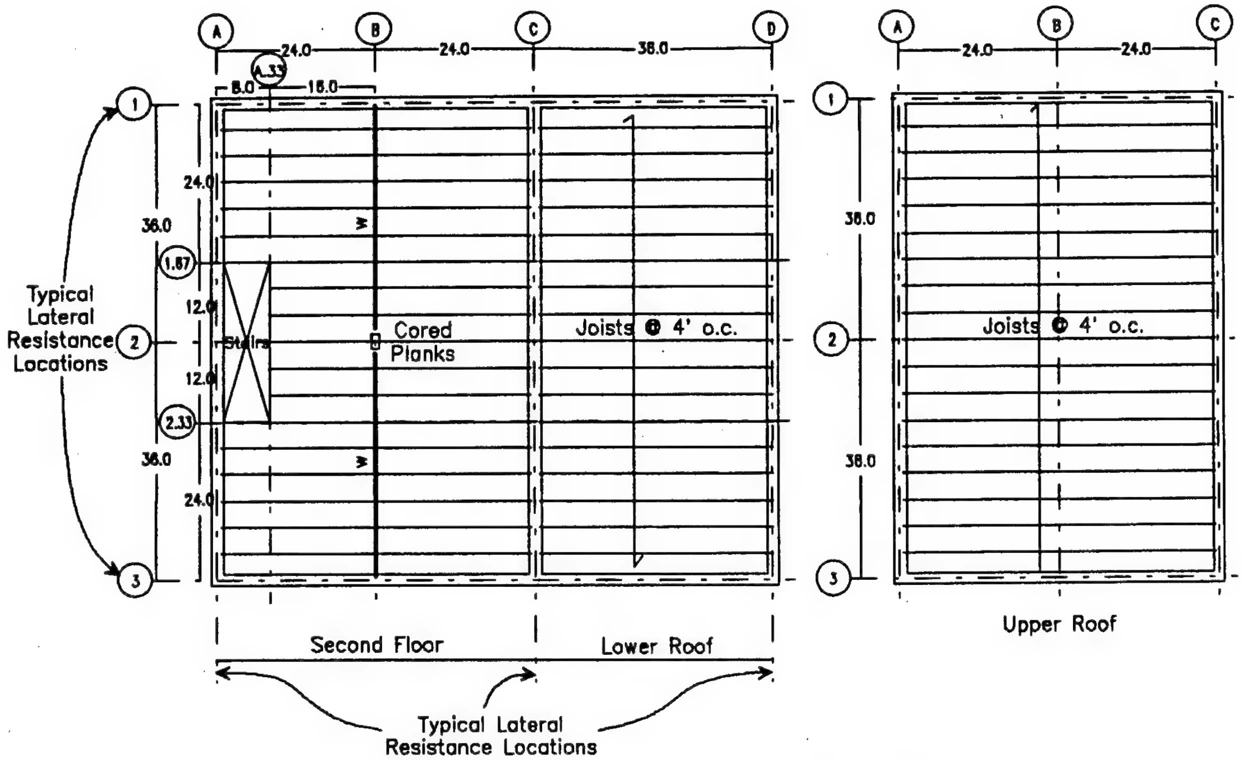
The structural engineers that become proficient with the use of CASM will be able to explore many other ideas to arrive at the most structurally efficient and economical solution for this hypothetical project.



Scheme 1: Moment connections for lateral load resistance

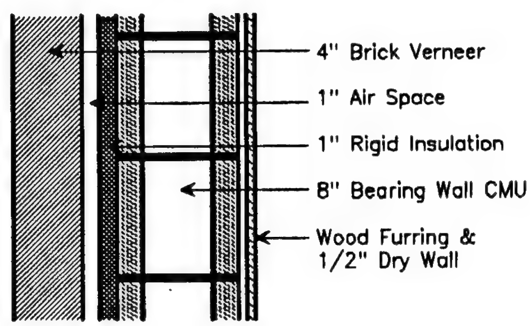
Scheme 2: Trussing for lateral load resistance





Scheme 3: Shear walls for lateral load resistance

8" CMU walls can be used as shear walls



REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1.AGENCY USE ONLY *(Leave blank)*

2.REPORT DATE
June 1996

3.REPORT TYPE AND DATES COVERED
Report 3 of a series

4.TITLE AND SUBTITLE
Computer-Aided Structural Modeling (CASM), Version 6.00; Report 3: Scheme A

5.FUNDING NUMBERS
Contract No. DACA39-86-C-0024
Work Unit No. AT40-CA-001

6.AUTHOR(S)
David Wickersheimer, Carl Roth, Gene McDermott

7.PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Wickersheimer Engineers, Inc.,
821 South Neil Street, Champaign, IL 61820

8.PERFORMING ORGANIZATION REPORT NUMBER

9.SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Corps of Engineers,
Washington, DC 20314-1000;
U.S. Army Engineer Waterways Experiment Station,
3909 Halls Ferry Road, Vicksburg, MS 39180-6199

10.SPONSORING/MONITORING AGENCY REPORT NUMBER
Instruction Report
ITL-96-2

11.SUPPLEMENTARY NOTES
Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

12a.DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b.DISTRIBUTION CODE

13.ABSTRACT *(Maximum 200 words)*

The Computer-Aided Structural Modeling (CASM) computer program is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional (3-D) interactive graphics. CASM allows the structural engineer to quickly evaluate various framing alternatives in order to make more informed decisions in the initial structural evaluation process. The program was developed by the Information Technology Laboratory in conjunction with the Computer-Aided Structural Engineering (CASE) Project, Building Systems Task Group.

This release of the CASM is designed to aid the user with design criteria, building loads, and structural framing and design. The various parts of the program are summarized below.

a. Basic design criteria. The user can enter information directly or retrieve information from a user-definable database. The design criteria include information about the project, regional design information, and site-specific design information.

b. Building geometry. The user can assemble the building shape using 3-D primitives (cubes, prisms, spheres, cylinders, etc.) in an easy manner using pull-down menus, icons, and a mouse.

(Continued)

14.SUBJECT TERMS

Building systems	Preliminary structural design
Computer-Aided Structural Engineering (CASE)	Structural modeling
	3-Dimensional interactive graphics
Computer programs	3-Dimensional loads

15.NUMBER OF PAGES
202

16.PRICE CODE

17.SECURITY CLASSIFICATION OF REPORT	18.SECURITY CLASSIFICATION OF THIS PAGE	19.SECURITY CLASSIFICATION OF ABSTRACT	20.LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED		

13. (Concluded).

c. Dead and live loads. The user can select and construct dead and live loads from several user-definable menus of building materials and load conditions. These loads can then be applied to any desired area of the building volume.

d. Snow and wind loads. These loads are automatically calculated in 3-D using information from the basic design criteria database. Wind loads are also calculated for components and cladding and open roof structures. These loads are calculated in accordance with TM 5-809-1.

e. Seismic loads. These loads are calculated based on the equivalent static force method presented in TM 5-809-10.

f. Structural layout. The engineer can easily and rapidly experiment with various framing schemes inside the defined building volume. Beams, girders, joists, girts, columns, walls, and custom trusses are some of the structural elements that can be modeled.

g. Member analysis and preliminary sizing. The user can apply loads to the building geometry from a list of user-defined load cases. The shear, moment, and deflection of selected members may be calculated for various loading conditions (including pattern loads) and connectivity (including continuous beams). The design of a member is performed using a spreadsheet.

Data from the various investigated framing schemes can be edited and printed by CASM and used as justification in a design document.

This report presents Scheme A, all steel, noncomposite, lateral load resistance for rigid frames.

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

	Title	Date
Technical Report K-78-1	List of Computer Programs for Computer-Aided Structural Engineering	Feb 1978
Instruction Report O-79-2	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Mar 1979
Technical Report K-80-1	Survey of Bridge-Oriented Design Software	Jan 1980
Technical Report K-80-2	Evaluation of Computer Programs for the Design/Analysis of Highway and Railway Bridges	Jan 1980
Instruction Report K-80-1	User's Guide: Computer Program for Design/Review of Curvilinear Conduits/Culverts (CURCON)	Feb 1980
Instruction Report K-80-3	A Three-Dimensional Finite Element Data Edit Program	Mar 1980
Instruction Report K-80-4	A Three-Dimensional Stability Analysis/Design Program (3DSAD)	
	Report 1: General Geometry Module	Jun 1980
	Report 3: General Analysis Module (CGAM)	Jun 1982
	Report 4: Special-Purpose Modules for Dams (CDAMS)	Aug 1983
Instruction Report K-80-6	Basic User's Guide: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Instruction Report K-80-7	User's Reference Manual: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Technical Report K-80-4	Documentation of Finite Element Analyses	
	Report 1: Longview Outlet Works Conduit	Dec 1980
	Report 2: Anchored Wall Monolith, Bay Springs Lock	Dec 1980
Technical Report K-80-5	Basic Pile Group Behavior	Dec 1980
Instruction Report K-81-2	User's Guide: Computer Program for Design and Analysis of Sheet Pile Walls by Classical Methods (CSHTWAL)	
	Report 1: Computational Processes	Feb 1981
	Report 2: Interactive Graphics Options	Mar 1981
Instruction Report K-81-3	Validation Report: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Feb 1981
Instruction Report K-81-4	User's Guide: Computer Program for Design and Analysis of Cast-in-Place Tunnel Linings (NEWTUN)	Mar 1981
Instruction Report K-81-6	User's Guide: Computer Program for Optimum Nonlinear Dynamic Design of Reinforced Concrete Slabs Under Blast Loading (CBARCS)	Mar 1981
Instruction Report K-81-7	User's Guide: Computer Program for Design or Investigation of Orthogonal Culverts (CORTCUL)	Mar 1981
Instruction Report K-81-9	User's Guide: Computer Program for Three-Dimensional Analysis of Building Systems (CTABS80)	Aug 1981
Technical Report K-81-2	Theoretical Basis for CTABS80: A Computer Program for Three-Dimensional Analysis of Building Systems	Sep 1981
Instruction Report K-82-6	User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)	Jun 1982

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Instruction Report K-82-7	User's Guide: Computer Program for Bearing Capacity Analysis of Shallow Foundations (CBEAR)	Jun 1982
Instruction Report K-83-1	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Jan 1983
Instruction Report K-83-2	User's Guide: Computer Program for Generation of Engineering Geometry (SKETCH)	Jun 1983
Instruction Report K-83-5	User's Guide: Computer Program to Calculate Shear, Moment, and Thrust (CSMT) from Stress Results of a Two-Dimensional Finite Element Analysis	Jul 1983
Technical Report K-83-1	Basic Pile Group Behavior	Sep 1983
Technical Report K-83-3	Reference Manual: Computer Graphics Program for Generation of Engineering Geometry (SKETCH)	Sep 1983
Technical Report K-83-4	Case Study of Six Major General-Purpose Finite Element Programs	Oct 1983
Instruction Report K-84-2	User's Guide: Computer Program for Optimum Dynamic Design of Nonlinear Metal Plates Under Blast Loading (CSDOOR)	Jan 1984
Instruction Report K-84-7	User's Guide: Computer Program for Determining Induced Stresses and Consolidation Settlements (CSETT)	Aug 1984
Instruction Report K-84-8	Seepage Analysis of Confined Flow Problems by the Method of Fragments (CFRAG)	Sep 1984
Instruction Report K-84-11	User's Guide for Computer Program CGFAG, Concrete General Flexure Analysis with Graphics	Sep 1984
Technical Report K-84-3	Computer-Aided Drafting and Design for Corps Structural Engineers	Oct 1984
Technical Report ATC-86-5	Decision Logic Table Formulation of ACI 318-77, Building Code Requirements for Reinforced Concrete for Automated Constraint Processing, Volumes I and II	Jun 1986
Technical Report ITL-87-2	A Case Committee Study of Finite Element Analysis of Concrete Flat Slabs	Jan 1987
Instruction Report ITL-87-1	User's Guide: Computer Program for Two-Dimensional Analysis of U-Frame Structures (CUFRAM)	Apr 1987
Instruction Report ITL-87-2	User's Guide: For Concrete Strength Investigation and Design (CASTR) in Accordance with ACI 318-83	May 1987
Technical Report ITL-87-6	Finite-Element Method Package for Solving Steady-State Seepage Problems	May 1987
Instruction Report ITL-87-3	User's Guide: A Three Dimensional Stability Analysis/Design Program (3DSAD) Module	Jun 1987
	Report 1: Revision 1: General Geometry	Jun 1987
	Report 2: General Loads Module	Sep 1989
	Report 6: Free-Body Module	Sep 1989

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Instruction Report ITL-87-4	User's Guide: 2-D Frame Analysis Link Program (LINK2D)	Jun 1987
Technical Report ITL-87-4	Finite Element Studies of a Horizontally Framed Miter Gate Report 1: Initial and Refined Finite Element Models (Phases A, B, and C), Volumes I and II Report 2: Simplified Frame Model (Phase D) Report 3: Alternate Configuration Miter Gate Finite Element Studies–Open Section Report 4: Alternate Configuration Miter Gate Finite Element Studies–Closed Sections Report 5: Alternate Configuration Miter Gate Finite Element Studies–Additional Closed Sections Report 6: Elastic Buckling of Girders in Horizontally Framed Miter Gates Report 7: Application and Summary	Aug 1987
Instruction Report GL-87-1	User's Guide: UTEXAS2 Slope-Stability Package; Volume I, User's Manual	Aug 1987
Instruction Report ITL-87-5	Sliding Stability of Concrete Structures (CSLIDE)	Oct 1987
Instruction Report ITL-87-6	Criteria Specifications for and Validation of a Computer Program for the Design or Investigation of Horizontally Framed Miter Gates (CMITER)	Dec 1987
Technical Report ITL-87-8	Procedure for Static Analysis of Gravity Dams Using the Finite Element Method – Phase 1a	Jan 1988
Instruction Report ITL-88-1	User's Guide: Computer Program for Analysis of Planar Grid Structures (CGRID)	Feb 1988
Technical Report ITL-88-1	Development of Design Formulas for Ribbed Mat Foundations on Expansive Soils	Apr 1988
Technical Report ITL-88-2	User's Guide: Pile Group Graphics Display (CPGG) Post-processor to CPGA Program	Apr 1988
Instruction Report ITL-88-2	User's Guide for Design and Investigation of Horizontally Framed Miter Gates (CMITER)	Jun 1988
Instruction Report ITL-88-4	User's Guide for Revised Computer Program to Calculate Shear, Moment, and Thrust (CSMT)	Sep 1988
Instruction Report GL-87-1	User's Guide: UTEXAS2 Slope-Stability Package; Volume II, Theory	Feb 1989
Technical Report ITL-89-3	User's Guide: Pile Group Analysis (CPGA) Computer Group	Jul 1989
Technical Report ITL-89-4	CBASIN–Structural Design of Saint Anthony Falls Stilling Basins According to Corps of Engineers Criteria for Hydraulic Structures; Computer Program X0098	Aug 1989

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Technical Report ITL-89-5	CCHAN–Structural Design of Rectangular Channels According to Corps of Engineers Criteria for Hydraulic Structures; Computer Program X0097	Aug 1989
Technical Report ITL-89-6	The Response-Spectrum Dynamic Analysis of Gravity Dams Using the Finite Element Method; Phase II	Aug 1989
Contract Report ITL-89-1	State of the Art on Expert Systems Applications in Design, Construction, and Maintenance of Structures	Sep 1989
Instruction Report ITL-90-1	User's Guide: Computer Program for Design and Analysis of Sheet Pile Walls by Classical Methods (CWALSHT)	Feb 1990
Technical Report ITL-90-3	Investigation and Design of U-Frame Structures Using Program CUFRBC Volume A: Program Criteria and Documentation Volume B: User's Guide for Basins Volume C: User's Guide for Channels	May 1990
Instruction Report ITL-90-6	User's Guide: Computer Program for Two-Dimensional Analysis of U-Frame or W-Frame Structures (CWFRAM)	Sep 1990
Instruction Report ITL-90-2	User's Guide: Pile Group–Concrete Pile Analysis Program (CPGC) Preprocessor to CPGA Program	Jun 1990
Technical Report ITL-91-3	Application of Finite Element, Grid Generation, and Scientific Visualization Techniques to 2-D and 3-D Seepage and Groundwater Modeling	Sep 1990
Instruction Report ITL-91-1	User's Guide: Computer Program for Design and Analysis of Sheet-Pile Walls by Classical Methods (CWALSHT) Including Rowe's Moment Reduction	Oct 1991
Instruction Report ITL-87-2 (Revised)	User's Guide for Concrete Strength Investigation and Design (CASTR) in Accordance with ACI 318-89	Mar 1992
Technical Report ITL-92-2	Finite Element Modeling of Welded Thick Plates for Bonneville Navigation Lock	May 1992
Technical Report ITL-92-4	Introduction to the Computation of Response Spectrum for Earthquake Loading	Jun 1992
Instruction Report ITL-92-3	Concept Design Example, Computer Aided Structural Modeling (CASM) Report 1: Scheme A Report 2: Scheme B Report 3: Scheme C	 Jun 1992 Jun 1992 Jun 1992
Instruction Report ITL-92-4	User's Guide: Computer-Aided Structural Modeling (CASM) -Version 3.00	Apr 1992
Instruction Report ITL-92-5	Tutorial Guide: Computer-Aided Structural Modeling (CASM) -Version 3.00	Apr 1992

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Continued)

	Title	Date
Contract Report ITL-92-1	Optimization of Steel Pile Foundations Using Optimality Criteria	Jun 1992
Technical Report ITL-92-7	Refined Stress Analysis of Melvin Price Locks and Dam	Sep 1992
Contract Report ITL-92-2	Knowledge-Based Expert System for Selection and Design of Retaining Structures	Sep 1992
Contract Report ITL-92-3	Evaluation of Thermal and Incremental Construction Effects for Monoliths AL-3 and AL-5 of the Melvin Price Locks and Dam	Sep 1992
Instruction Report GL-87-1	User's Guide: UTEXAS3 Slope-Stability Package; Volume IV, User's Manual	Nov 1992
Technical Report ITL-92-11	The Seismic Design of Waterfront Retaining Structures	Nov 1992
Technical Report ITL-92-12	Computer-Aided, Field-Verified Structural Evaluation	
	Report 1: Development of Computer Modeling Techniques for Miter Lock Gates	Nov 1992
	Report 2: Field Test and Analysis Correlation at John Hollis Bankhead Lock and Dam	Dec 1992
	Report 3: Field Test and Analysis Correlation of a Vertically Framed Miter Gate at Emsworth Lock and Dam	Dec 1993
Instruction Report GL-87-1	User's Guide: UTEXAS3 Slope-Stability Package; Volume III, Example Problems	Dec 1992
Technical Report ITL-93-1	Theoretical Manual for Analysis of Arch Dams	Jul 1993
Technical Report ITL-93-2	Steel Structures for Civil Works, General Considerations for Design and Rehabilitation	Aug 1993
Technical Report ITL-93-3	Soil-Structure Interaction Study of Red River Lock and Dam No. 1 Subjected to Sediment Loading	Sep 1993
Instruction Report ITL-93-3	User's Manual—ADAP, Graphics-Based Dam Analysis Program	Aug 1993
Instruction Report ITL-93-4	Load and Resistance Factor Design for Steel Miter Gates	Oct 1993
Technical Report ITL-94-2	User's Guide for the Incremental Construction, Soil-Structure Interaction Program SOILSTRUCT with Far-Field Boundary Elements	Mar 1994
Instruction Report ITL-94-1	Tutorial Guide: Computer-Aided Structural Modeling (CASM); Version 5.00	Apr 1994
Instruction Report ITL-94-2	User's Guide: Computer-Aided Structural Modeling (CASM); Version 5.00	Apr 1994
Technical Report ITL-94-4	Dynamics of Intake Towers and Other MDOF Structures Under Earthquake Loads: A Computer-Aided Approach	Jul 1994
Technical Report ITL-94-5	Procedure for Static Analysis of Gravity Dams Including Foundation Effects Using the Finite Element Method – Phase 1B	Jul 1994

(Continued)

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

(Concluded)

	Title	Date
Instruction Report ITL-94-5	User's Guide: Computer Program for Winkler Soil-Structure Interaction Analysis of Sheet-Pile Walls (CWALSSI)	Nov 1994
Instruction Report ITL-94-6	User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)	Nov 1994
Instruction Report ITL-94-7	User's Guide to CTWALL – A Microcomputer Program for the Analysis of Retaining and Flood Walls	Dec 1994
Contract Report ITL-95-1	Comparison of Barge Impact Experimental and Finite Element Results for the Lower Miter Gate of Lock and Dam 26	Jun 1995
Technical Report ITL-95-5	Soil-Structure Interaction Parameters for Structured/Cemented Silts	Aug 1995
Instruction Report ITL-95-1	User's Guide: Computer Program for the Design and Investigation of Horizontally Framed Miter Gates Using the Load and Resistance Factor Criteria (CMITER-LRFD)	Aug 1995
Technical Report ITL-95-8	Constitutive Modeling of Concrete for Massive Concrete Structures, A Simplified Overview	Sep 1995
Instruction Report ITL-96-1	User's Guide: Computer Program for Two-Dimensional Dynamic Analysis of U-Frame or W-Frame Structures (CDWFRM)	Jun 1996
Instruction Report ITL-96-2	Computer-Aided Structural Modeling (CASM), Version 6.00 Report 1: Tutorial Guide Report 2: User's Guide Report 3: Scheme A Report 4: Scheme B Report 5: Scheme C	Jun 1996
Instruction Report ITL-96-	User's Guide: Computer Program for the Design and Investigation of Horizontally Framed Miter Gates Using the Load and Resistance Factor Criteria (CMITERW-LRFD) Windows Version	Jul 1996